GENERAL DYNAMICS/CONVAIR

Dec. 12/62

INSTRUCTION COVER SHEET

TO: All Holders of
MAINTENANCE MANUAL
Model 30

AMERICAN CS-61-057
VARIG CS-61-060
CS-61-063

SUBJECT: COMPLETE REPLACEMENT - CHAPTER 21
Dated Nov. 15/62

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Remove and destroy all pages now in your manual for Chapter 21. Insert the attached pages to replace those pages just removed.

BRIEF DESCRIPTION OF CHANGES:

1. Updated and/or expanded the following sections to incorporate latest Hamilton Standard design changes and/or Convair changes: 21-0, 21-1-1, 21-2-0, 21-3-0, 21-3-1, 21-3-2, 21-3-7 through 21-3-11, 21-4-3, 21-4-5, 21-4-10, and 21-6-0.

2. Added section 21-1-11, Heat Control Modulating Valve Maintenance Practices.

3. Added section 21-1-12, Servo Pressure Shutoff Valve Maintenance Practices.

4. Added Freon filter Description and Operation in section 21-3-1.

5. Added section 21-3-17, Freon Compressor Motor Protector Maintenance Practices.

6. Retain Temporary Revisions 21-18 and 21-19 in your manual until applicable airplanes have been modified per Convair Service Bulletin 24-5.

7. Retain Temporary Revisions 21-20 and 21-21 in your manual until applicable airplanes have been modified per Convair COR 30-22019.

8. Retain Temporary Revisions 21-23 and 21-25 in your manual until applicable airplanes have been modified per Hamilton Standard Service Bulletin 21-24.

9. Retain Temporary Revisions 21-22, 21-24, and 21-26 through 21-28 in your manual until applicable airplanes have been modified per Hamilton Standard Service Bulletin 21-19.

10. Retain Temporary Revisions 21-29 and 21-30 in your manual until applicable airplanes have been modified per Hamilton Standard Service Bulletin 21-18.

11. Remove Temporary Revisions 21-1 through 21-4, 21-6, 21-9 and 21-10 from your manual as they are no longer applicable.

NOTE: Temporary Revisions 21-5, 21-7, 21-8 and 21-11 through 21-17, are not applicable to airplanes CV-1 through CV-25 and CV-35 and on.

LIST OF EFFECTIVE PAGES

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AIR CONDITIONING

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21-0	102	Nov. 15/62	AB-2
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21-0	105	Nov. 15/62	AB-2
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21-0	107	Nov. 15/62	AB-2
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*Pages revised, added or deleted by this revision.

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*Pages revised, added or deleted by this revision.

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AIR CONDITIONING

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TEMPORARY REVISION NO. 21-22.

Insert facing 21-0, Page 101, dated Nov. 15/62 (or subsequent).

The instructions in this temporary revision are applicable to airplanes not modified per Hamilton Standard Service Bulletin 21-19. For airplanes modified per Hamilton Standard Service Bulletin 21-19, use the information on Page 101.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 101, NOTE: near bottom of page should read "If during this check the indicated liquid level drops below the red "low-charge" mark and does not immediately rise above the red mark, shut down and recharge the Freon package."

AIR CONDITIONING AND PRESSURIZATION - DESCRIPTION AND OPERATION

1. General

All pressurized compartments of the airplane can be maintained at a sea-level cabin altitude up to an airplane altitude of 20,500 feet, and an 8000-foot cabin altitude up to an airplane altitude of 41,000 feet. The capabilities of the airplane's pressurization system are shown on Figure 1. The air conditioning system supplies circulating fresh air, heated or cooled as conditions require, either on the ground or during flight. Under normal conditions a complete change of air is provided in the cabin every 2-1/2 minutes and in the flight compartment every minute. The air conditioning system is shown on Figure 2.

Presetting of the rate of change of the cabin pressure controller permits rapid changes in flight altitude with a minimum rate of change of cabin altitude. Two cabin pressure regulator and outflow valves are provided to automatically limit the pressure differential to a predetermined value. Should either valve malfunction, the other valve is capable of maintaining a normal cabin pressure schedule at the normal maximum rate of flow delivered by the pressure source. In the event of a malfunctioning of the automatic features of both cabin pressure regulator outflow valves, both valves can be actuated manually by control switches on the flight engineer's control panel. The air conditioning system consists of two systems connected in parallel, but function independently of each other. Each of the systems have separate controls for either automatic or manual operation. One system primarily supplies the flight compartment and the other primarily the cabin. Since the airflow required for the flight compartment is less than for the cabin, the excess conditioned air of the flight compartment system is supplied to the cabin. Each air conditioning system is capable of supplementing the other should one of them malfunction. Heating and cooling of the baggage compartments and the electrical and electronic equipment is also provided by the air conditioning system.

2. Major Components

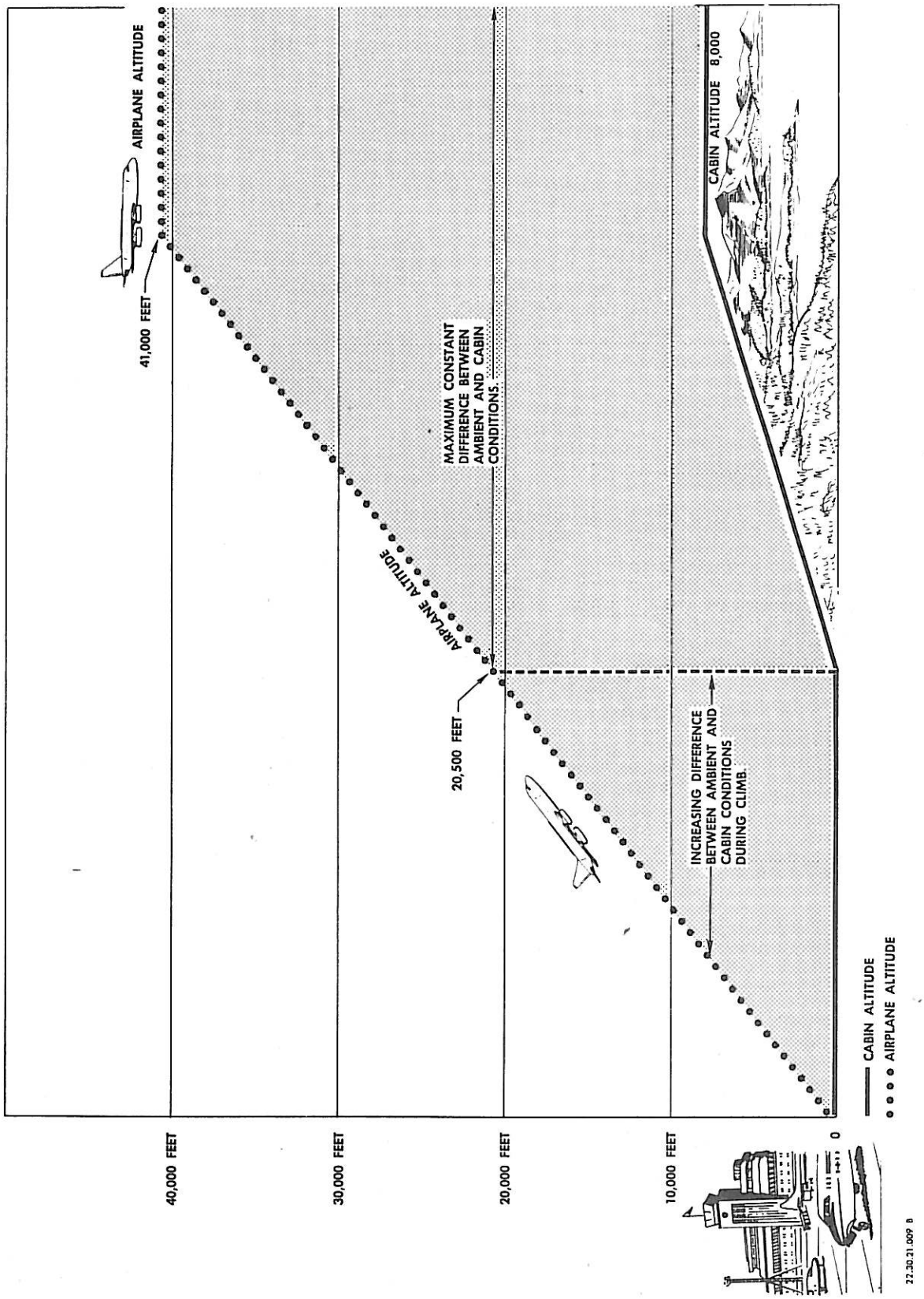
The major components in each air conditioning and pressurization system include the following:

A. The turbocompressor unit which provides pressurized and heated air.

B. The air-to-air heat exchanger which furnishes primary cooling of pressurized air in flight.

C. The Freon subsystem which provides secondary cooling.

D. The temperature control and temperature equalization subsystems which maintain the air temperature at a selected level.


AIRPLANE ALTITUDE
41,000 FEET
MAXIMUM CONSTANT DIFFERENCE BETWEEN AMBIENT AND CABIN CONDITIONS.
CABIN ALTITUDE 8,000
AIRPLANE ALTITUDE
20,500 FEET
INCREASING DIFFERENCE BETWEEN AMBIENT AND CABIN CONDITIONS DURING CLIMB.
CABIN ALTITUDE
AIRPLANE ALTITUDE
40,000 FEET
30,000 FEET
20,000 FEET
10,000 FEET
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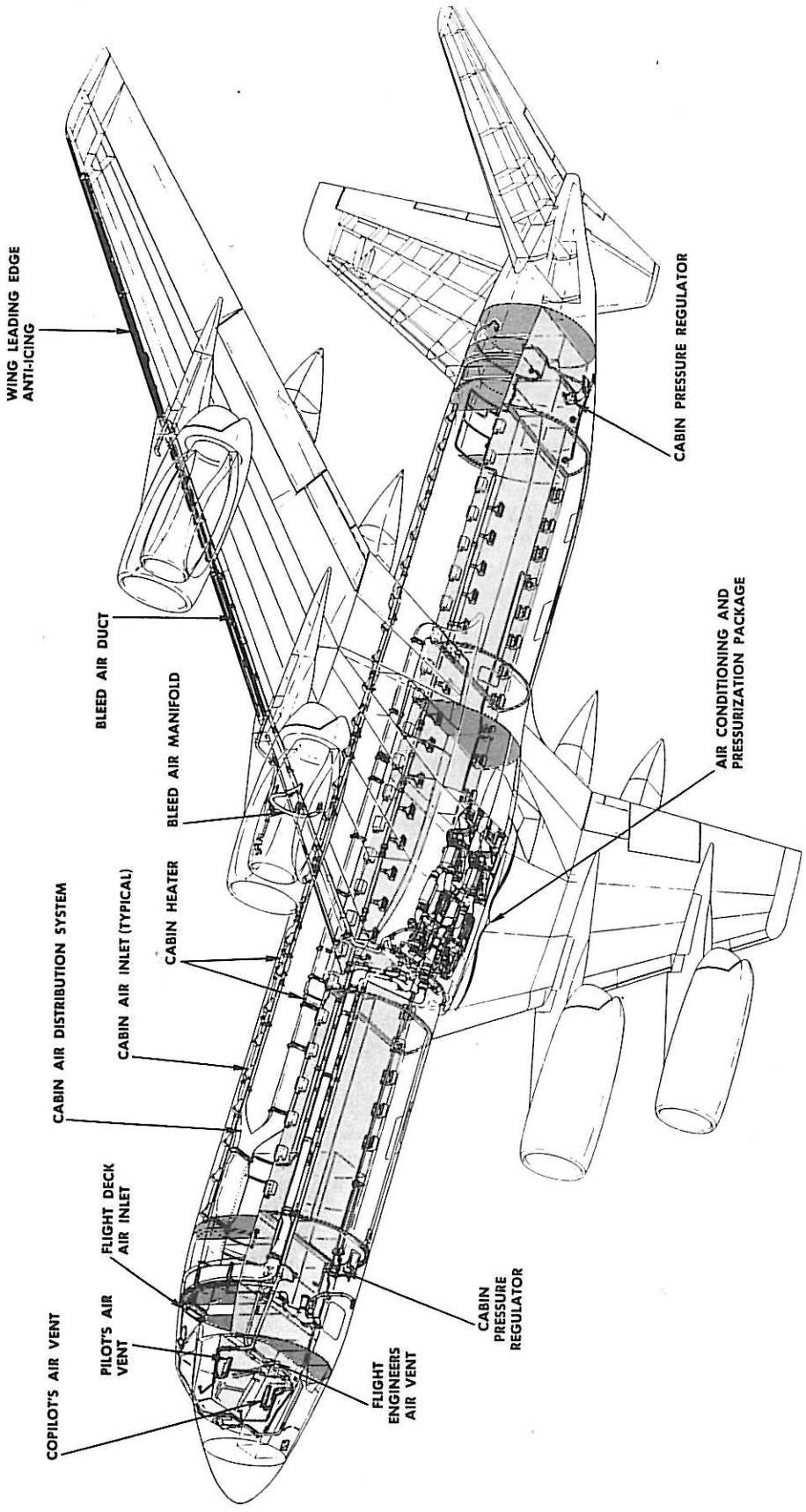

Air Conditioning and Pressurization System
Figure 2

E. The electric heaters which heat the flight deck and cabin air.

F. The pressurization control subsystem.

The components of the subsystems are electrically tied together so that normal automatic operation is maintained. A series of switches on the flight engineer's control panel provides automatic or manual control.

3. System Operation - General

A. Engine Bleed Air.

Bleed air is manifolded from the 17th stage of each of the four turbojet engines into a single bleed air supply line or manifold located in the wing leading edge. This bleed air is used to drive the turbocompressors, supply emergency pressurization, anti-ice the wing leading edges and engine air inlet areas, and provide a source of air for the windshield rain clearing system. For further information on the bleed air system refer to Chapter 36, PNEUMATICS. The bleed air used in the air conditioning and pressurization system is tapped off the single bleed air supply line and is routed to the turbine sections of the two turbocompressors (see Figure 3) and is then discharged overboard.

The compressor section of the turbocompressor draws in, compresses and heats ram air. The heated air is then routed through the air-to-air heat exchanger for primary cooling and through the Freon evaporator for secondary cooling. The cooled and compressed air is then discharged into the flight compartment and cabin by their respective systems to air condition and pressurize these areas.

B. Controls.

Automatic or manually operated temperature controls regulate the temperature of the air discharged into the cabin and flight compartment. When more heat is required, these controls open valves that recirculate the compressed ram air back through the turbocompressor for additional heating. The temperature controls also regulate the amount of heat dissipated at the air-to-air heat exchanger and Freon evaporator. Electric heaters are used for flight deck and cabin ground heating. The temperature equalization system controls the cabin air electric heater operation to maintain a maximum temperature differential of 2 degrees F between the divided portions of the cabin. When more cooling is required, the compressed air is routed directly to the primary and secondary cooling systems without being recirculated through the compressor. Both the air-to-air heat exchanger and Freon evaporator can be regulated from essentially no cooling to full cooling, dependent upon the cooling requirements.

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AA-1

Air Conditioning and Pressurization Package
Figure 3

C. Air Recirculation.

A recirculation subsystem provides a means of ventilating and cooling the airplane compartments on the ground. This system is controlled by a switch on the flight engineer's control panel, and when turned on, the system draws air from the cabin. This air is ducted back into the air conditioning subsystem downstream of the air-to-air heat exchanger where it is cooled or heated depending on the demands of the cabin. The Freon subsystem cools and dehumidifies the recirculated air and electric heaters provide supplementary heating when required. Although normally used only for ground operation, the recirculation subsystem can be utilized in flight should one of the turbocompressors malfunction. By utilizing recirculation with the remaining operating turbocompressor, normal circulation through the cabin and flight compartment can be maintained.

D. Emergency Pressurization.

Engine bleed air may be used for emergency pressurization of the cabin and flight compartment in the event both turbocompressors fail. Bleed air is ducted into the air conditioning subsystem downstream of the turbocompressor where it is cooled by the air-to-air heat exchanger and the Freon evaporator. This conditioned bleed air is then discharged into the cabin and flight compartments.

E. Ram Air.

A ram air shutoff valve, downstream of the Freon evaporator, provides a means of routing fresh air to the cabin and flight compartments. The ram air shutoff valve is manually controlled by a toggle switch on the flight engineer's panel. Regardless of control switch operation, the valve will open only when ram air pressure exceeds cabin pressure. Thus, when the airplane is pressurized, the pressurization system provides a flow of fresh air. If the normal or emergency pressurization systems are not being used, the ram air shutoff valve can be opened to provide fresh air.

F. Ground Cart Operation.

Compartment heating or cooling, when the engines are shut down, can be accomplished by connecting an external source of electrical power to the airplane to operate the electric heaters or Freon packages.

G. Applicable to airplanes CV-35 and on, the cabin and flight compartment can be heated or cooled after engine shutdown by connecting an external air conditioning unit to the air conditioning system's ground connection. This externally heated or cooled air is ducted directly to the cabin and flight compartments and bypasses the air conditioning system.

AIR CONDITIONING AND PRESSURIZATION - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. IN AUTOMATIC OPERATION CABIN TEMPERATURES RISE ABOVE SELECTED SETTING (No indication of malfunction on flight engineer's control panel)	
A. Faulty operation of items used in automatic operation.	Manually operate temperature control system for maximum cooling. If adequate cooling is available when in manual control, check items which operate only during automatic operation. Using procedure as shown with GS-1278 check for correct operation of heat exchanger cool air modulating valve, heat control modulating valve and electronic temperature controller. Replace malfunctioning unit.
B. Malfunctioning sequencing device or electronic temperature controller.	Manually operate temperature control system for maximum cooling. Use GS-1278 to determine if sequencing device is at maximum cooling position as directed by the electronic temperature controller. Check operation of sequencing device through all quadrants of operation using GS-1278. If malfunction appears in sequencing device, remove and replace unit. If malfunction does not appear in sequencing device check electronic temperature controller with GS-1278; remove and replace if faulty. If the units are in maximum cooling position but preset cooling temperature cannot be maintained, check Freon level in Freon liquid level gauges. NOTE: If during check the indicated liquid level drops to the red DRAIN-RECHARGE area and does not immediately rise to the green OPERATING RANGE, shut system down and recharge Freon package(s).
C. Freon compressor of one air conditioning system does not operate.	Check operation of FREON FAIL warning light. If defective replace bulb or repair electrical circuitry as required. If warning light is "on", or if visual check indicates locknut relay has tripped, check that compressor overpressure discharge switch, overheat

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. IN AUTOMATIC OPERATION CABIN TEMPERATURES RISE ABOVE SELECTED SETTING (No indication of malfunction on flight engineer's control panel.) (CONT)	
	switch and compressor discharge overtemp switch are open. If open, press reset switch; Freon compressor should now be able to be started.
D. No voltage to Freon compressor motor, open current limiters.	Check compressor motor current limiters for indication of open circuit. If all three are open check each power lead and motor winding for a short to ground. If only two limiters are open, check for open airplane wiring or open wiring within compressor motor. Repair as needed; if open motor winding, replace Freon package. If limiters open immediately upon replacing, malfunction is a high potential short within compressor motor; replace Freon package.
E. No voltage to Freon compressor compressor motor relay open.	Check that back pressure regulating valve is closed. If open use GS-1278 to check for malfunctioning back pressure regulating valve, and Freon back pressure control. If back pressure control is bad, replace control. If back pressure regulating valve is malfunctioning, replace Freon package.
	Check for 28-volt dc between compressor motor relay and ground. If not present, remove input plug from locknut relay and measure between pin A and ground for 28-volt. If no voltage remove plug from sequencing device and measure between N and ground for 28-volt. If no voltage present run continuity check back to 28-volt dc source through Freon compressor ON-OFF and Freon compressor FLT DK OFF-BOTH ON-CABIN OFF control switches; repair as required.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. IN AUTOMATIC OPERATION CABIN TEMPERATURES RISE ABOVE SELECTED SETTING (No indication of malfunction on flight engineer's control panel) (CONT)	
F. No voltage to Freon compressor; lockout relay malfunction.	Remove input plug from compressor lockout relay, measure between pin A and ground for 28-volt dc. If present measure between terminal L and ground for continuity. If no continuity, trouble shoot airplane wiring through time delay thermister.
2. CABIN TEMPERATURE FALLS BELOW SELECTED SETTING (No indication of malfunction on flight engineer's panel.)	
A. Faulty operation of items which operate only in automatic control.	Manually operate temperature control system for maximum heating. Check operation of sequencing device and electronic temperature controller using GS-1278 for correct operation and position. If either unit does not operate correctly, remove and replace. Check those items which are used only during flight (heat exchanger cooling air modulating valve and heat control modulating valve). Use GS-1278 to check valves. Replace any valve which indicates a malfunction.
B. Faulty operation of temperature selector and thermal resistor bridge.	When operated manually and heat is available, check operation of the temperature selector. When measured at disconnect plug of electronic temperature controller (pin 4 to 6), the temperature selector should show a resistance of not more than 100-ohms (full hot position) to no more than 9000-ohms (full cold) position. While reading ohmmeter rotate temperature selector from HOT to COLD. If not within this range, remove and replace temperature selector. Check resistance of temperature pickups. Measure between pins of electronic temperature controller plug for: duct temp pick-up, pins 2 to 5; cabin or flight deck pickup, pins 4 to 1. The resistance should approximate the following:

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

2. CABIN TEMPERATURE FALLS BELOW SELECTED SETTING (No indication of malfunction on flight engineer's panel.) (CONT)

AIR TEMP	RESISTANCE
120°F	3.2K to 4K
75°F	9.8K to 10.2K
54°F	17K to 20K

NOTE: These readings are also the same for the CMTC thermister.

NOTE: For a quick isolation of a defective unit, substitute a unit known to be good.

C. Sequencing device malfunctioning.

Using test set GS-1278, check operation of cams in sequencing device. Check this unit from one extreme to the other, noting carefully voltage and time as cams traverse from full hot to full cold. Refer to 21-4-0, air conditioning control and indication for correct schedule. If malfunctioning unit is found, remove and replace.

D. Malfunction in units which operate only during ground operation.

Schedule full hot with temperature selector. Note that recirculation fan starts and that heated air is available at cabin and/or flight deck conditioned air outlets. There should be 200-volts ac line to line at each element of flight deck heater. If correct voltage is not available, remove plug from sequencing device and check continuity from terminal T to terminals L, S, E, K, V, W and X of sequencing device. If open, remove and replace sequencing device. If OK, remove limit switch plug from electric heater. Measure between terminal A and ground for 28-volts dc.

E. Malfunction in flight deck heater limit switch control circuit.

Remove limit switch plug from electric heater. Check continuity between terminals A and B. If open, remove and replace heater. If OK, trace 28-volt dc from terminal T of sequencing device to landing gear ground safety

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
2. CABIN TEMPERATURE FALLS BELOW SELECTED SETTING (No indication of malfunction on flight engineer's panel.) (CONT)	
	relay through FLT DK OFF-BOTH ON-CABIN OFF switch to the GRD HEATER circuit breaker and to 28-volt dc bus.
F. Malfunction in electric heater.	Remove power from air conditioning system and check continuity of all heater elements. If one or more elements are open, replace heater. If OK, check position of recirculation air control valve; recirculation control valve should be fully opened; replace valve if malfunctioning.
G. Inadequate heating from turbo-compressor package.	Schedule maximum heating from turbo-compressor package using test set GS-1278. Disconnect heat recirculation temperature limiter control servo tube. Cap removed tube. If turbo-compressor temperature increases, malfunction is in heat recirculation temperature limiter control. Remove and replace control. If discharge temperature remains constant use test set GS-1278 to monitor operation of heat control modulating valve. If valve actuator is malfunctioning check circuitry between valve and electronic temperature controller. If circuitry is OK, replace valve; if circuitry is faulty, repair as necessary. If valve actuator is OK, malfunction is probably within heat control modulating valve; remove and replace valve.
3. FLIGHT ENGINEER'S CONTROL PANEL INDICATES MALFUNCTION WITHIN FREON PACKAGE (FREON FAIL light "on")	
A. Inadequate cooling of condenser.	Check air passage through core. If OK, and inadequate condenser cooling exists only during flight, simulate flight operation and check operation of condenser cool air modulating valve, condenser temperature control, and thermal resistor (CMTC). Replace malfunctioning component. If flight

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
3. FLIGHT ENGINEERS'S CONTROL PANEL INDICATES MALFUNCTION WITHIN FREON PACKAGE (FREON FAIL light "on") (CONT)	
	conditions are satisfactory, check that condenser fan is operating. Check that cool air modulating valve is fully closed. If open, remove power plug and check for 115-volt from terminal D to G and from E to G. If no voltage is found, a defective condenser cooling control relay, open in wiring, or a malfunctioning condenser temperature control exists. Isolate and repair as necessary. If these are operating correctly, malfunction is in condenser cool air modulating valve; replace valve.
B. Condenser fan Malfunctioning.	Check for 28-volt dc across condenser fan motor relay coil. If no voltage check reset on fan lockout relay. If control circuit is open, fan has probably overheated; check for blocked duct. If ducting is obstructed clean as required. If not blocked, replace condenser fan. If relay is not locked out, check for 28-volt dc from fan motor relay to ground. If voltage is correct, internal ground through lockout relay has been broken; replace condenser fan. If no voltage exists check wiring through condenser cooling control relay, condenser ground cooling valve, sequencing device, and to the 28-volt dc bus.
C. Malfunction in fan control circuit or in condenser fan motor windings.	Check continuity of fan motor power relay coil. If open replace relay. If good, check contacts for completion of power circuit; if malfunction is determined, remove and replace. If 115/200-volt ac not available to fan motor relay, check current limiters from ac essential bus; remove and replace limiters as required. If limiters are OK, remove and replace condenser fan. If less than three limiters are open, check for short in airplane wiring or in fan motor. Repair or replace as necessary.

TEMPORARY REVISION NO. 21-23.

Insert facing 21-0, Page 107, dated Nov. 15/62 (or subsequent).

The instructions in this temporary revision are applicable to airplanes not modified per Hamilton Standard Service Bulletin 21-24. For airplanes modified per Hamilton Standard Service Bulletin 21-24, use the information on Page 107.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 107, in step 4.B. under ISOLATION PROCEDURE AND CORRECTION, delete the following sentence "If thermal switch is ok, replace pilot relay on motor protector."

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
4. "AIRFLOW" INDICATOR SHOWS LOSS OF COMPLETE SYSTEM FLOW DURING GROUND OPERATION (Normal flow indicated during flight.)	
A. Recirculation fan not operating.	Check 115/200-volt ac limiter in power leads from ESS AC BUS to fan motor relay and to recirculation fan. If limiters are open check fan and airplane wiring for continuity and shorts. Repair or replace as necessary. Check mechanical operation of fan motor; if defective replace fan.
B. Recirculation fan not operating, 115/200-volt ac available.	Place RECIRCULATING BLOWER AUTO-OFF-MAN ON switch in MAN ON position. Voltage on terminal 1 should read 28-volt dc to ground. Repair or replace switch or wiring as necessary. Make a voltage and ground check on X_1 and X_2 of the recirculation fan motor relay. If no voltage on X_1 repair airplane wiring as necessary or check operation of recirculation control valve. If no ground on X_2 check lockout relay. Make a voltage check from terminal A to ground of the recirculation fan motor. If 28-volt dc is not found on terminal A, repair airplane wiring as necessary. If there is 28-volt dc on terminal C and lockout relay has been reset, replace lockout relay. If there is 28 volts on terminal C and lockout relay will not reset, check for a failed closed thermal switch in fan motor; if closed, replace fan motor. If thermal switch is OK, replace pilot relay on motor protector. If correct voltages are found as above and recirculation fan does not operate, malfunction is in mechanical components of fan motor; replace fan.
C. Recirculation control valve malfunctioning	Place RECIRCULATING BLOWER switch first in OFF position, then in the MAN-ON position; recirculation control valve shall open. Replace valve if malfunctioning.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
5. HALF SYSTEM FLOW INDICATED (Airflow indicator shows half system operation with no other malfunction indicated on flight engineer's control panel)	
A. Malfunction in airflow sensor system.	Check for operation of airflow sensors by operating recirculation fan and checking operation of sensor or indicator. Substitute sensor and indicator known to be good for each unit. Remove and replace defective unit. If still not giving true indication, check airplane wiring, using standard techniques. Remove plug from airflow indicator on flight engineer's control panel; with 28-volts dc POWER OFF, continuity between terminal A to B (cabin) will show resistance, terminal C to D (flt deck) will show resistance. Also, check from each terminal to ground for possible short.
B. Restriction in airflow within ducts, heat exchanger or check valves.	Check for airflow from turbocompressor package; if no airflow trouble shoot turbocompressor package. Check for a malfunctioning turbocompressor check valve, or a blocked or broken duct to the heat exchanger. Remove and replace as necessary. Check for a blocked heat exchanger core. Clean as required.
C. Conditioned air emergency or ram air shutoff valve malfunctioning.	Check operation of conditioned air emergency shutoff valve. If malfunction is indicated in valve, remove and replace valve. If no malfunction indicated, defect may be in wiring. Remove plug from valve, pin A to C (open) should read 115-volts ac with no voltage from pin B to C (close). If correct voltages are not present, check voltage to AC source through Freon compressor CABIN OFF-BOTH ON FLT-DK switch to circuit breaker on NO. 2 ESS AC BUS. Repair wiring or replace switch or circuit breaker as required. Check position of ram air shutoff valve; this should be in CLOSE position (PRESSURE SOURCE switch in CLOSE position). If open, remove connector to valve and measure between pins B to C for 115-volts ac. If correct, replace valve. If incorrect check continuity from plug to RAM AIR

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
5. HALF SYSTEM FLOW INDICATED (Airflow indicator shows half system operation with no other malfunction indicated on flight engineer's control panel)(CONT)	
	SOURCE switch and to NO. 2 ESS AC BUS. Repair wiring or replace switch or circuit breaker as necessary.
6. AIRFLOW INDICATOR SHOWS HALF SYSTEM OPERATION, TURBOCOMPRESSOR RPM INDICATOR AT ZERO (No other indication on flight engineer's control panel. Turbocompressor will not start when switch is toggled)	
A. Possible malfunction in solenoid air shutoff valve or associated circuitry.	Remove plug from turbocompressor shutoff valve: Measure from A to C (ground) for 28-volts dc. If voltage exists, replace turbocompressor shutoff valve. If no voltage, replace plug and check overspeed relay for tripped condition. If not tripped, check that reverse thrust relay is deactivated and that 28-volts dc is available from turbocompressor AUTO-OFF-MAN ON switch and from TURBO COMPR ON circuit breaker. Repair or replace components as necessary.
B. Short in turbocompressor.	Remove turbocompressor power plug and check for a short from V, U, R or S of this plug. If short exists, trouble is in wiring between plug and 28 VOLT DC ESS BUS. Replace components or repair wiring as necessary. Check for short from A or B to ground of turbocompressor shutoff valve. If none exists malfunction is in turbocompressor. Remove plug from overspeed control on turbocompressor package. Check for short from V, U, R, and S of overspeed control to ground. If short exists, turbocompressor wiring harness or accessories are shorted; remove and replace package. If short is no longer present, malfunction is within overspeed control and turbocompressor must be replaced.
	NOTE: If all electrical components of the turbocompressor system are functioning in a normal manner, but the turbocompressor does not operate, the malfunction is within the turbocompressor package pneumatic system.

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION

7. INADEQUATE AIR HEATING FROM TURBOCOMPRESSOR PACKAGE (Compressor discharge temperature constant when heating is scheduled)

A. Malfunctioning recirculation temperature limiter control, recirculation altitude shutoff control, or heat control modulating valve.	Disconnect heat recirculation temperature limiter servo tube. Cap removed tube. With test set GS-1278 schedule inflight heating. If turbocompressor discharge temperature increases, remove and replace heat recirculation temperature limiter control. If temperature remains constant, reconnect temperature limiter control servo tube. Disconnect recirculation altitude shutoff control servo tube. Cap "tee" fitting to valve servo line. With GS-1278, schedule inflight heating. If temperature increases, remove and replace recirculation altitude shutoff control. If turbocompressor discharge temperature remains constant, check operation of heat control modulating valve. Use test set GS-1278 to monitor operation of actuator and valve. Visually check position of valve. If malfunction is in valve actuator electrical circuits, check continuity of wiring from valve actuator to electronic temperature controller. Repair airplane wiring as necessary. If the unit's electrical operation is normal, remove and replace heat control modulating valve.

8. TURBOCOMPRESSOR PACKAGE WILL NOT OPERATE (No overspeed indication on flight engineer's panel)

A. Possible overspeed malfunction.	Test bulb and circuit in overspeed warning system; replace bulb and repair circuitry as necessary. If bulb lights and indicates an overspeed malfunction, refer to Step 10, TURBOCOMPRESSOR OVERSPEED malfunction. If malfunction is not an overspeed condition, check operation of turbocompressor shutoff valve. Disconnect overspeed vent line from valve port "30" and cap port in valve. If turbocompressor shutoff valve remains closed,

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
8. TURBOCOMPRESSOR PACKAGE WILL NOT OPERATE (No overspeed indication on flight engineer's panel) (CONT)	
	remove and replace this valve. If turbocompressor operates, malfunction is in overspeed control; remove and replace turbocompressor package.
9. TURBOCOMPRESSOR OUTPUT LOW (ENGINE BLEED AIR SUPPLY pressure correct and AIRFLOW indicator reading low)	
A. Servo pressure malfunction.	Visually check that turbocompressor shutoff valve is fully open. If valve is not fully open, remove and replace. If turbocompressor shutoff valve is open, measure pressure to turbocompressor servo inlet. Pressure should be 9.0 psig minimum; if below this value repair or replace airplane servo bleed air lines as required (refer to Chapter 36, PNEUMATICS). If servo inlet air pressure is above 9.0 psig measure servo bleed air pressure at pressure regulator outlet; this pressure shall be 10.5 psig or more. If less, remove and replace pressure regulator. If pressure is correct remove and replace turbocompressor package.
B. Surge valve or surge control malfunctioning.	Manually check turbocompressor surge discharge port. If surge valve is closed, malfunction is between the turbocompressor and the outlet to the cabin or flight deck. Repair ducting as required. If surge valve is open, check for a blocked duct or a restriction in duct, such as a foreign object or dent. Repair or replace ducts as necessary. If ducting is satisfactory, disconnect servo air line from pressure regulator outlets and attach a pressure gage; regulator output pressure shall be 10.5 psig or more. If regulator outlet pressure is correct, connect a flexible tube to outlet pressure regulator and to inlet port of surge valve. If surge valve does not close, remove and replace surge valve. If surge valve closes and normal turbocompressor discharge flow is

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
9. TURBOCOMPRESSOR OUTPUT LOW (ENGINE BLEED AIR SUPPLY pressure correct and AIRFLOW indicator reading low) (CONT)	
	resumed, replace turbocompressor; malfunction is in surge control which cannot be replaced during line maintenance.
10. TURBOCOMPRESSOR OVERSPEED	
A. Overspeed cutout actuator malfunction.	Reset overspeed cutout and re-run turbocompressor; observe RPM, airflow and bearing temperature indicators and overspeed light. If RPM and airflow appear normal but overspeed trips, malfunction is in overspeed cutout actuator. Remove and replace turbocompressor. If airflow and RPM are above normal, remove tubing between flow control and pressure regulator valve. Attach a pressure gage to pressure regulator valve outlet; pressure shall be between 10.5 and 16 psig when turbocompressor is operated. If pressure exceeds 16 psig, remove and replace pressure regulator. If trouble persists check engine bleed air pressure; pressure shall not exceed 42 psig. If pressure is correct and turbocompressor rpm is low, check port "22" on venturi duct, and port "21" on piezometer for obstruction. Check sensing tubes and ports for obstructions; clean or replace as necessary. If obstruction in ports or sensing tubes, malfunction is in flow control of bias pressure control. Remove and replace turbocompressor. If pressures as measured above are correct, and turbocompressor approaches overspeed, malfunction is in nozzle actuator. Remove and replace turbocompressor.
B. Pressure regulator portion of pressure regulator and relief valve malfunctioning. Overspeed cutout has not actuated, RPM higher than usual.	Start turbocompressor and observe RPM, airflow and bearing temperature indicators. If both RPM and airflow indications are above normal with no malfunction indicated on bearing temperature gage, replace pressure regulator and relief valve.

AIR CONDITIONING AND PRESSURIZATION SYSTEM - MAINTENANCE PRACTICES

1. Adjustment/Test

A. General.

The following procedure provides a functional check of the turbocompressors, air conditioning packages, recirculation fan, temperature and temperature equalization control systems and the associated control valves. The procedure does not check the operation of the pressurization control system. The Adjustment/Test procedure for the cabin pressure controller and pressure-regulating outflow valves is covered in 21-2-0, PRESSURIZATION CONTROLS AND INDICATION.

The functional test may be performed either with the engines operating, or by using ground carts to supply electrical and pneumatic power.

B. Equipment Required.

(1) External source of 115/200-volt, 3-phase, 400 cycle ac electrical power (refer to Chapter 24, ELECTRICAL POWER).

(2) External source of pneumatic power (15-40 psig).

(3) Voltmeter.

(4) Dry ice.

C. Preparation.

(1) Ascertain that the following limiters have been installed in ac power distribution box.

(a) COND GND COOL CABIN.

(b) FREON COND CABIN.

(c) COND GND COOL FLT DECK.

(d) FREON COND FLT DECK.

(e) RECIRC FAN MOTOR.

(2) Place the following switches on the flight engineer's control panel in the positions indicated.

(a) RECIRCULATING BLOWER switch - OFF.

(b) FREON MASTER ON-OFF switch - OFF.

(c) FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch - BOTH ON.

(d) Cabin and flight deck AUTO-OFF-MAN temperature control switch - OFF.

(e) Cabin and flight deck turbocompressor AUTO-OFF-MAN ON switches - OFF.

(f) CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors - centered.

(g) CABIN TEMP EQ CONT switch - OFF.

(h) Cabin and flight deck MAN HOT-MAN COLD switches - centered.

(i) PRESSURE SOURCE - CLOSE.

(3) Ascertain that LH and RH landing gear ground safety switches are in ground position.

(4) Close the following circuit breakers on flight engineer's panel.

(a) RECIRC FAN CONT.

(b) CABIN & FLT DECK AIR SOV.

(c) EVAP AIR SHUTOFF VALVE.

(d) Cabin and flight deck ELEC TEMP CONTROL.

(e) RH and LH LANDING GEAR GRD SAFETY RELAYS.

(f) Cabin and flight deck CONDENSER GROUND COOLING.

(g) ELEC COMPT FAN CONT.

(h) Cabin and flight deck TURBO COMPR INDICATOR.

(i) Cabin and flight deck TURBO COMPR ON.

(j) Cabin and flight deck TURBO COMPRESSOR OFF.

(k) CABIN FREON SYS CONT.

(l) FLT DECK FREON SYS CONT.

(m) CABIN TEMP EQUALIZER CONTROL AC.

(n) CABIN FREON CONT.

(o) CABIN TEMP EQUALIZER RELAY DC.

(p) LH and RH WING and FUS EXCESS HEAT WARN and BLEED AIR VALVE WARN LTS.

(q) AIR FLOW IND.

(r) GRD MOD CONT.

(s) GROUND HEATER CONT.

(5) Ascertain the following valves are closed and remain closed during entire test operation.

(a) Wing anti-ice shutoff valves.

(b) Engine starter control valves.

(c) Engine bleed air regulator and check valves.

(d) Cabin emergency pressurization shutoff valves.

(e) Nose cowl duct lip anti-ice air control valves.

(f) Windshield rain clearing shutoff valves.

(6) Check operation of warning lights on air conditioning and pressurization control panel. (Test switch is on lower right portion of flight engineer's control panel above oxygen control panel.)

(7) Open turbocompressor and Freon package compartment access doors.

(8) Open IGNITION POWER SYSTEM I and II (8) and IGNITION SEL (1) circuit breakers.

(9) Connect external source of pneumatic power to airplane (refer to Chapter 71, POWER PLANT-GENERAL).

(10) Connect external source of electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

D. Air Conditioning System Ground Test.

(1) Place cabin AUTO-OFF-MAN temperature control switch in MAN position; cabin heat exchanger cooling air modulating valve shall open (if not already open).

(2) Place RECIRCULATING BLOWER switch in AUTO position and check for the following:

(a) Recirculation air control valve shall open.

(b) Recirculation fan shall start after recirculation valve opens.

(c) COMPRESSOR AIR FLOW indicator shall indicate approximately equal flow for cabin and flight deck systems.

(3) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in CABIN OFF position and check for the following:

(a) Cabin conditioned air emergency shutoff valve shall close and crossover shutoff valve shall open.

(b) Cabin side of COMPRESSOR AIR FLOW indicator shall indicate no flow.

(c) Flight deck conditioned air emergency shutoff valve shall remain open and flight deck side of COMPRESSOR AIR FLOW indicator shall indicate increased flow.

(4) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in FLT DECK OFF position and check for the following:

(a) Flight deck conditioned air emergency shutoff valve shall close as cabin conditioned air emergency shutoff valve opens.

(b) Crossover shutoff valve shall remain open.

(c) Flight deck side of COMPRESSOR AIR FLOW indicator shall indicate no flow and cabin side of indicator shall indicate increased flow.

(5) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position and check for the following:

(a) Crossover shutoff valve shall close.

(b) Flight deck conditioned air emergency shutoff valve shall open and cabin and flight deck sides of COMPRESSOR AIR FLOW indicator shall indicate approximately equal flow.

(6) Ascertain that cabin and flight deck condenser cooling air modulating valves are closed and condenser ground cooling valves are open. (Valves are located between aft edge of Freon package access doors and condenser fans.)

(7) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in MAN position.

(8) Place cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN COLD position and hold for two minutes.

(9) Place Freon MASTER ON-OFF switch in ON position and check for the following:

(a) Cabin and flight deck Freon packages shall start.

TEMPORARY REVISION NO. 21-24.

Insert facing 21-0, Page 205, dated Nov. 15/62 (or subsequent).

The instructions in this temporary revision are applicable to airplanes not modified per Hamilton Standard Service Bulletin 21-19. For airplanes modified per Hamilton Standard Service Bulletin 21-19, use the instructions on Page 205.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted service bulletin.

Page 205, second sentence in CAUTION following step (9)(b) should read "IF INDICATED LIQUID LEVEL IS NOT BETWEEN RED LINE AND ADJACENT BLACK LINE, SHUT DOWN SYSTEM AND SERVICE FREON PACKAGE."

(b) Freon condenser fans shall start before Freon compressors.

CAUTION: CHECK FREON LIQUID LEVEL GAGES FOR STABLE READING IMMEDIATELY AFTER FREON PACKAGES START OPERATING. IF INDICATED LIQUID LEVEL DOES NOT STABILIZE WITHIN THE GREEN OPERATING RANGE, SHUT DOWN SYSTEM(S) AND SERVICE FREON PACKAGE(S) (REFER TO CHAPTER 12, SERVICING).

(c) Air supplied to cabin and flight deck systems shall be cool.

(10) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in FLT DECK OFF position; flight deck Freon package shall shut down and cabin Freon package shall continue to operate.

NOTE: System response shall be the same as noted in step (4).

(11) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in CABIN OFF position; cabin Freon package shall shut down and flight deck package shall continue to operate.

NOTE: System response shall be the same as noted in step (3).

(12) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position; cabin Freon package shall start and flight deck Freon package shall continue to operate.

NOTE: System response shall be the same as noted in step (5).

(13) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors to approximately 80 percent (2 o'clock) position. (Ambient temperature 65 degrees F minimum.)

(14) Close FLT DECK HEATER CONT circuit breakers in Freon package compartment.

(15) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in AUTO position; check that the following occurs within two minutes:

(a) Cabin and flight deck Freon packages shall shut down.

(b) Cabin and flight deck electric heaters shall supply heat.

(c) Cabin heat exchanger cooling air modulating valve shall remain open.

(16) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in CABIN OFF position; cabin and flight deck heaters shall continue to heat.

NOTE: System component operation shall be as noted in step (11).

(17) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in FLT DECK OFF position; flight deck heater shall stop heating and cabin heaters shall continue to heat.

NOTE: System component operation shall be as noted in step (10).

(18) Place FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch in BOTH ON position; cabin heaters shall continue to heat and flight deck heater shall start heating.

NOTE: System component operation shall be as noted in step (12).

NOTE: Step (19) should be accomplished quickly to avoid tripping heater thermal overload switches unnecessarily. If switches should trip, allow sufficient time for heaters to cool and switches to reset before proceeding with test.

(19) Place RECIRCULATING BLOWER switch in OFF position and check for the following:

(a) Recirculation fan shall stop and recirculation air control valve shall close.

(b) Flight deck electric heater shall shut off when recirculation valve is closed.

(c) Cabin electric heaters shall continue to heat unless heater internal thermal limit switches, or 160°F thermal limit switches actuate.

(20) Place RECIRCULATING BLOWER switch in AUTO position and check for the following:

(a) Recirculation air control valve shall open and recirculation fan shall start.

(b) Flight deck electric heater shall start heating.

(21) Place cabin and flight deck AUTO-OFF-MAN temperature control switches in MAN position and rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors to full cold (counterclockwise) position.

(22) Place cabin MAN HOT-MAN COLD temperature control switch in MAN HOT position and hold for one minute; cabin electric heaters shall continue to heat until 160°F thermal limit switch actuates. The cabin sequencing device shall reverse to stop the heating cycle and possibly initiate a cooling cycle by starting the cabin Freon package.

(23) Place cabin AUTO-OFF-MAN temperature control switch in AUTO position; cabin Freon package shall start operating if not already started.

(24) Repeat steps (22) and (23) substituting flight deck switches for cabin switches; results shall be the same as indicated for cabin system.

(25) Place CABIN TEMP EQ CONT switch in OFF position.

CAUTION: ASCERTAIN THAT TURBOCOMPRESSORS HAVE BEEN SERVICED AND FILLED WITH OIL, SPECIFICATION MIL-L-6085.

(26) Apply external source of air pressure (40 psig) to ground high pressure connection.

(27) Place three BLEED AIR DUCT ISOLATION switches in MAN OPEN position (overhead switch panel); bleed air duct isolation valves shall open.

(28) Place cabin compressor AUTO-OFF-MAN switch in MAN ON position; cabin turbocompressor shall start.

(29) Immediately after cabin turbocompressor starts, place RECIRCULATING BLOWER switch in OFF position; recirculation air control valve shall close and recirculation air fan shall stop. Check for the following:

(a) Cabin COMPR RPM indicator shall indicate approximately 20,000 (±2,000) RPM.

(b) Cabin side of COMPRESSOR AIR FLOW indicator shall indicate approximately 85 to 105 pounds per minute airflow.

(c) Cabin COMPR BEARING TEMP indicator shall indicate approximately 65 (±5.5) degrees C (150 (±10) degrees F).

CAUTION: AN INCREASE IN TURBOCOMPRESSOR RPM MAY BE ACCOMPANIED BY A GRADUAL INCREASE IN BEARING TEMPERATURE. THIS INCREASE IN TEMPERATURE IS NORMAL, PROVIDED A MAXIMUM TEMPERATURE OF 250°F (121.1°C) IS NOT EXCEEDED. HOWEVER, AN ABRUPT INCREASE IN BEARING TEMPERATURE NOT ACCOMPANIED BY AN INCREASE IN RPM IS CAUSE FOR IMMEDIATE SHUTDOWN OF THE TURBOCOMPRESSOR BEFORE THE MAXIMUM TEMPERATURE LIMIT IS REACHED.

(30) Place flight deck compressor AUTO-OFF-MAN ON switch in MAN ON position; flight deck turbocompressor shall start and gage readings shall be as indicated for cabin turbocompressor operation in step (29).

(31) Place cabin compressor AUTO-OFF-MAN ON switch in AUTO position; cabin turbocompressor shall stop.

(32) Place RECIRCULATING BLOWER switch in AUTO position and immediately place flight deck compressor AUTO-OFF-MAN ON switch in AUTO position; flight deck turbocompressor shall stop, recirculation air control valve shall open and recirculation fan shall start. Proceed to airborne operational test.

E. Air Conditioning System Airborne Operational Test.

(1) Disconnect electrical harness from cabin and flight deck Freon package compressors. (Cap electrical receptacle and connector.)

CAUTION: FREON PACKAGES SHALL NOT BE OPERATED WHEN SYSTEM IS IN AIRBORNE CONFIGURATION AS THERE WILL BE NO AIRFLOW THROUGH CONDENSER.

(2) Place LH and RH landing gear ground safety switches and landing gear down and locked switch in airborne position (refer to Chapter 32, LANDING GEAR); check for the following:

(a) Recirculation air control valve shall close and recirculation fan shall stop.

(b) Cabin and flight deck turbocompressor shall start.

(3) Rotate CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL selectors to full hot (clockwise) position and check for the following:

(a) Cabin and flight deck heat exchanger cool air modulating valves shall close.

(b) Cabin and flight deck turbocompressor heat control modulating valves shall actuate toward open position.

(c) Cabin and flight deck electric heater shall remain inoperative.

(4) Place cabin and flight deck compressor AUTO-OFF-MAN ON switches in OFF position; cabin and flight deck turbocompressors shall stop.

(5) Place RECIRCULATING BLOWER switch in MAN position; recirculation air control valve shall open and recirculation fan shall start.

(6) Place RECIRCULATING BLOWER switch in AUTO position; recirculation fan shall stop and recirculation air control valve shall close.

(7) Place cabin and flight deck compressor AUTO-OFF-MAN ON switches in AUTO position; cabin and flight deck turbocompressors shall start.

(8) Place CABIN TEMP CONTROL and FLIGHT DECK TEMP CONTROL AUTO-OFF-MAN switches in MAN position.

(9) Place cabin and flight deck MAN HOT-MAN COLD temperature control switches in MAN COLD position and hold for two minutes; check for the following:

(a) Cabin and flight deck turbocompressor heat control modulating valves shall close.

(b) Cabin and flight deck heat exchanger cool air modulating valves shall open.

(10) Place LH and RH landing gear ground safety switches and landing gear down and locked switch in ground position and check for the following:

(a) Cabin and flight deck turbocompressors shall shut down.

(b) Recirculation air control valves shall open and recirculation fan shall start.

(11) Allow systems to stabilize in this configuration for one-half minute prior to shutting down.

F. Operational Check of Ram Air Shutoff Valves.

(1) Ascertain that RAM AIR SHUTOFF VALVE circuit breaker is closed.

(2) Place RAM AIR SOURCE switch in OPEN position; cabin and flight deck ram air shutoff valve actuators shall rotate to open position within two minutes.

NOTE: Ascertain actuator position by observing position indicator on valve. Valves are near top of turbocompressor compartments just aft of compartment access doors.

(3) Place RAM AIR SOURCE switch in close position; cabin and flight deck ram air shutoff valve actuators shall rotate to closed position within two minutes.

G. Shut Down Air Conditioning System.

(1) Place switches on air conditioning and pressurization control panel in the following positions:

(a) Cabin and flight deck compressor AUTO-OFF-MAN switches - OFF.

(b) RECIRCULATING BLOWER switch - OFF.

(c) Freon MASTER ON-OFF switch - OFF.

(d) FREON COMPRESSOR FLT DECK OFF-BOTH ON-CABIN OFF switch - CABIN OFF.

(e) RAM AIR SOURCE switch - CLOSE.

(f) Cabin and flight deck AUTO-OFF-MAN temperature control switches - OFF.

(g) Cabin and flight deck TEMP CONTROL selectors - centered.

(h) CABIN TEMP EQ CONT switch - OFF.

(2) Disconnect and remove ground electrical and pneumatic power carts from airplane.

(3) Close air conditioning and pressurization compartment access doors.

PRESSURIZATION SUBSYSTEM - DESCRIPTION AND OPERATION

1. General

To distinguish between the pressurization subsystem and the air conditioning subsystem it is necessary to recognize the different functions of some of the components and subsystems. The primary function of the pressurization subsystem is to pressurize the airplane. The primary function of the air conditioning subsystem is to condition the air directed to the flight and passenger compartments for passenger and crew comfort. The primary function of the turbocompressor is to pressurize air for cabin pressurization but, as the air is pressurized, it is also heated; this is a function of the air conditioning subsystem. If warmer air is needed for the air conditioning subsystem the air can be recirculated through the turbocompressor by the heat control modulating valve. The turbocompressor and the heat control modulating valve are a part of the pressurization subsystem although they also function as a part of the air conditioning subsystem. The pressure regulator and outflow valves and pressurization controls are concerned with pressurization only. The pressurization control subsystem is covered in 21-2-0, PRESSURIZATION CONTROLS AND INDICATION.

The 17th stage of each of the four turbojet engine compressors provides a source of bleed air with a maximum pressure of 237 psig and a maximum temperature of 867 degrees (464 degrees C). The engine bleed air valves regulate the pressure to 40 (±5) psig. For more details on the bleed air system, refer to Chapter 36, PNEUMATICS. This bleed air is ducted from the bleed air supply line or manifold to the variable area nozzle in the turbine section of the turbocompressor when the turbocompressor shutoff valve is in the open position. The turbocompressor shutoff valve is electrically controlled by its respective AUTO-OFF-MAN ON switch as well as being pneumatically controlled by the overspeed cutout. The bleed air from the variable area nozzle rotates the turbocompressor turbine and is then exhausted directly overboard. As the turbine rotates, it turns an impeller to draw in ambient ram air from the plenum chamber and compresses it for cabin pressurization and air conditioning. The compressor impeller is mounted on the same shaft as the turbine. To provide heated pressurized air, as prescribed by the temperature control system, the heat control modulating valve recirculates a portion of the pressurized air back through the compressor to increase its temperature. This reheated air is limited to approximately 240 degrees F (116 degrees C) by a temperature limiter control that senses compressor outlet air temperature. The heated air then passes through a flow control sensor and enters the primary and secondary cooling stages before being discharged into the cabin and flight compartment. Refer to 21-3-0, AIR CONDITIONING SUBSYSTEM for a description of the cooling of pressurized air.

The conditioned air, after it is discharged into the cabin and flight compartment, is then directed to the forward and aft cabin pressure regulator and outflow valves. For a more detailed explanation of the air distribution system refer to 21-9-0, AIR DISTRIBUTION SYSTEM. Section 21-2-0 covers the pressurization control and indication. Outflow of air from the pressurized areas of the fuselage is controlled through the cabin pressure regulator

and outflow valves. The outflow valves restrict air flow to maintain a cabin pressure as called for by the pressurization control subsystem. In the event one outflow valve should malfunction the other outflow valve is capable of maintaining a normal cabin pressure regulation schedule.

The maximum capacity of the pressurization subsystem is a mass flow of 160 pounds per minute at sea level and varies approximately linearly with altitude to 120 pounds per minute at 35,000 feet. Minimum airflow for normal operation is 47 pounds per minute at sea level and varies approximately linearly with altitude to 35 pounds per minute at 35,000 feet.

In the event the flight compartment loses pressure during normal flight, due to a windshield blowing out or other similar failure, cabin-to-flight compartment pressure will be equalized through operation of the flight compartment access door. When flight compartment pressure is lost, cabin pressure will "blow-in" the access door on its hinges. "Blow-in" will occur at a maximum differential pressure between the flight compartment and cabin.

TURBOCOMPRESSOR ASSEMBLY - DESCRIPTION AND OPERATION

1. General

The turbocompressor assembly, shown on Figure 1, is a pneumatically driven, air pressurizing assembly consisting of a turbine-powered centrifugal compressor. The turbocompressor, using engine bleed air to drive the turbine, compresses fresh ram air in the compressor section. The compressed air is supplied to the air conditioning and pressurization system at a proper weight flow and pressure to pressurize the airplane compartments.

Turbocompressor control, shown schematically on Figure 2, is achieved through a network of servomechanisms, sensors and indicators. The description and operation of each of these controls follows.

2. Turbocompressor Shutoff Valve

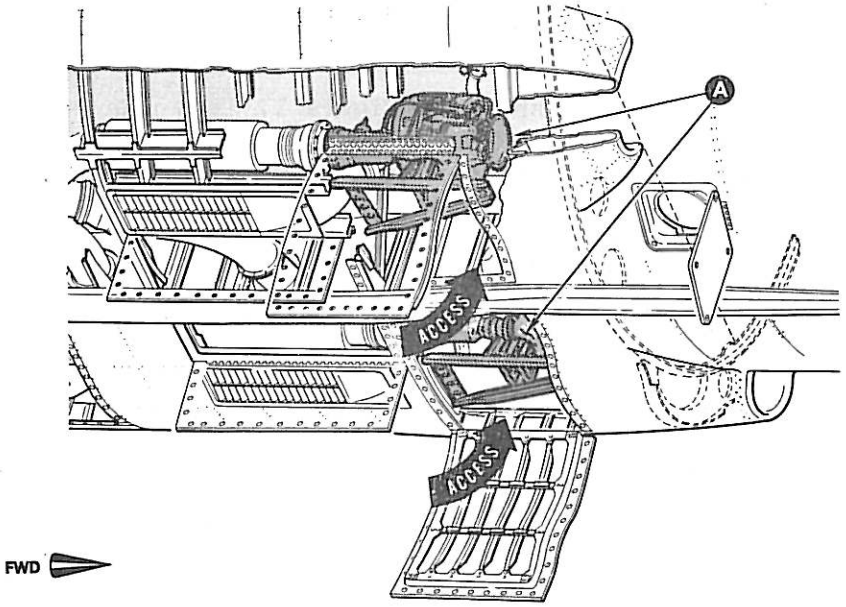
A. Description.

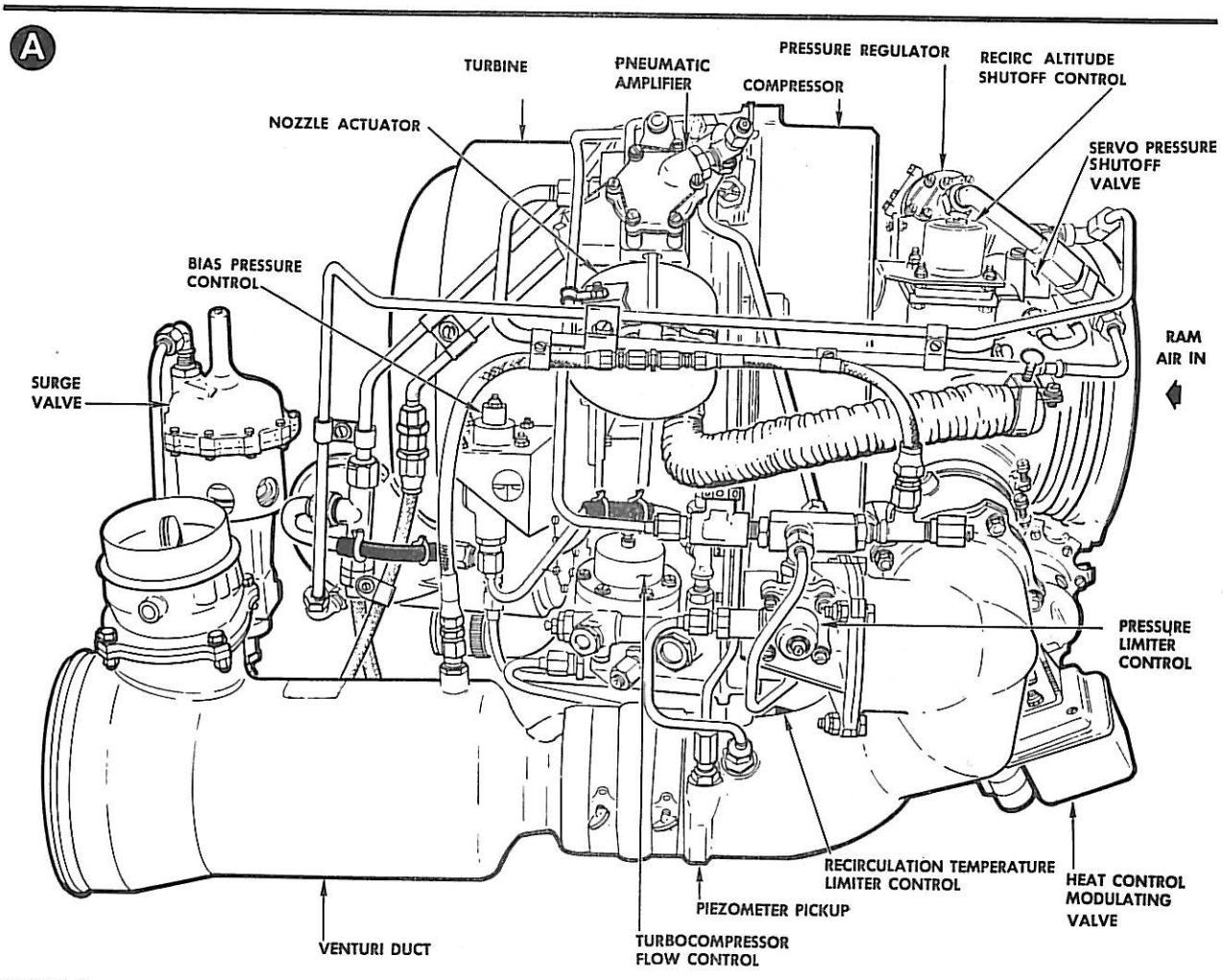
The turbocompressor shutoff valve provides the means for turning the turbocompressor on or off by either permitting or interrupting engine bleed air to the turbine section of the turbocompressor. The shutoff valve, illustrated on Figure 3, consists of a housing, a butterfly valve, a pneumatic actuator, and an electric solenoid. The butterfly valve is mechanically linked to the actuator shaft which in turn connects to two differential pistons in dual chambers. Servo passageways connects both actuator chambers to a servo tap upstream of the butterfly. The servo passageway on the large piston side of the orifice has two vents. One vent is ducted to the overspeed control which keeps the vent closed except in an overspeed condition. The second vent is closed by the solenoid which is a part of the valve and is mounted on the actuator. The solenoid is wired to a switch in the overspeed control and connects externally to a landing gear ground safety relay and the turbocompressor AUTO-OFF-MAN ON switches.

B. Operation.

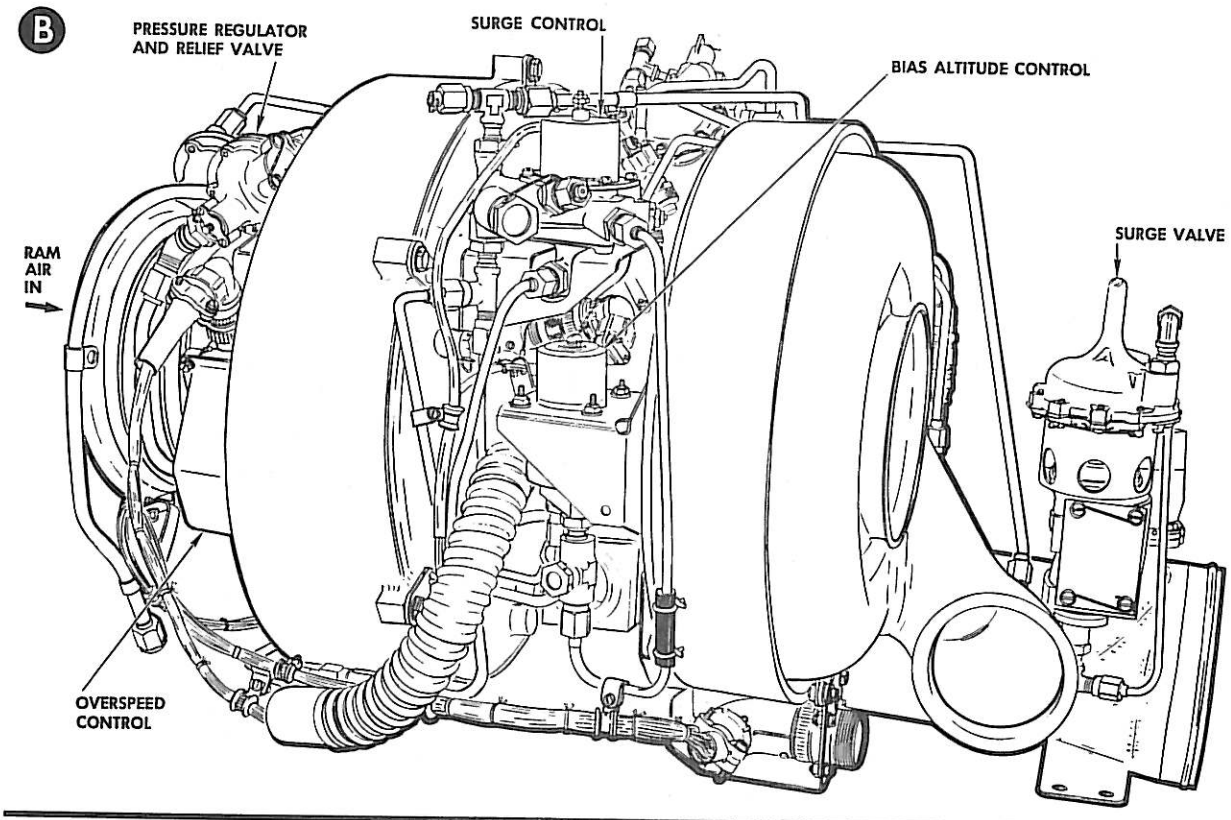
Valve operation can be ascertained by following the schematic illustrated on Figure 3. Engine bleed air pressure is applied through a filter screen and passageways to both actuator chambers to open the valve. Pressure on the larger diaphragm creates a greater total force than on the smaller diaphragm causing the actuator pistons to move toward the small actuator chamber. This movement opens the butterfly valve allowing engine bleed air to pass to and drive the turbocompressor.

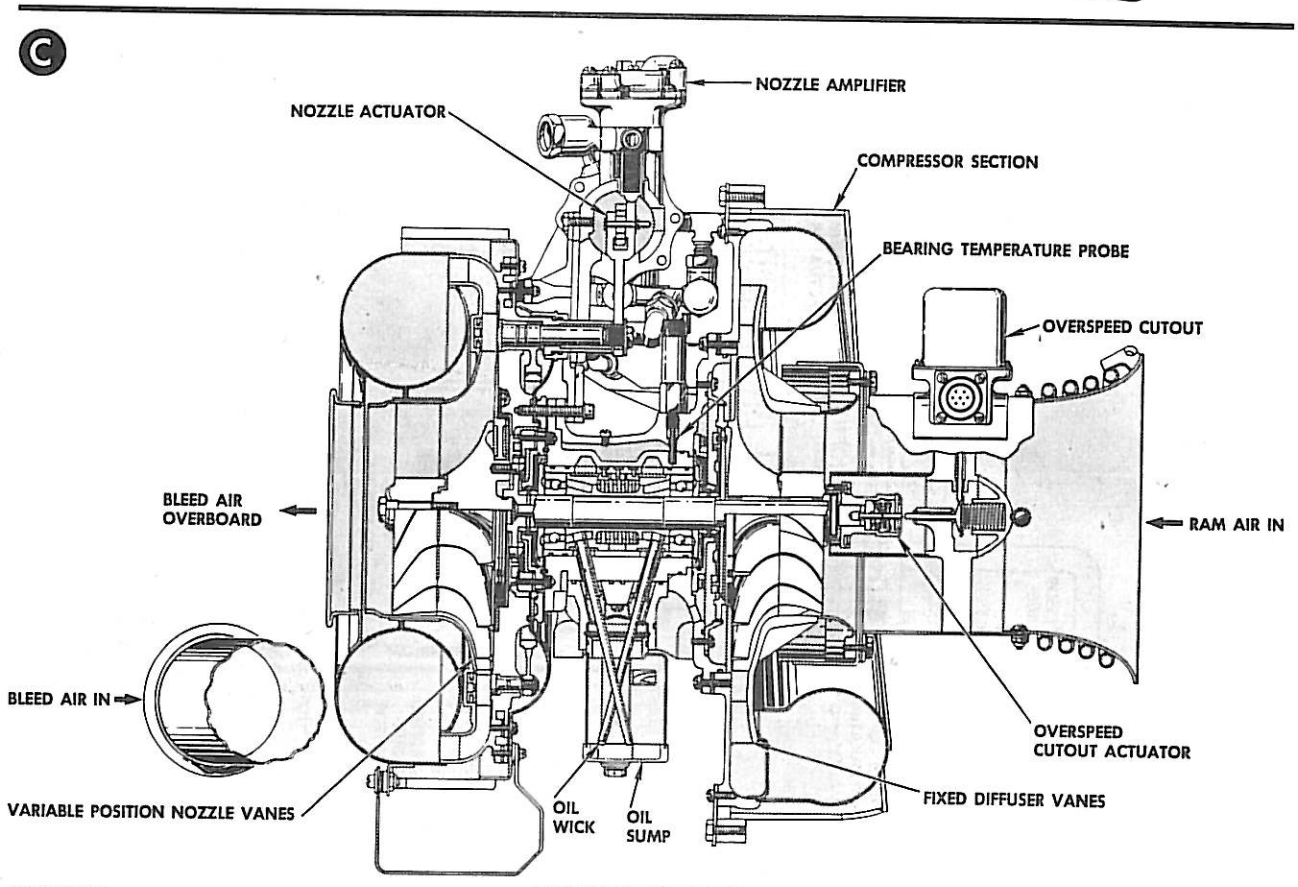
When the air pressure in the servo passageway to the large actuator chamber is vented by either the overspeed control poppet valve or the shutoff valve solenoid, the shutoff valve closes. The air pressure in the smaller actuator chamber, due to the restriction of the orifice, will maintain a greater pressure on the small diaphragm when the large chamber is vented, causing the actuator pistons to move toward the large actuator chamber and close the valve.



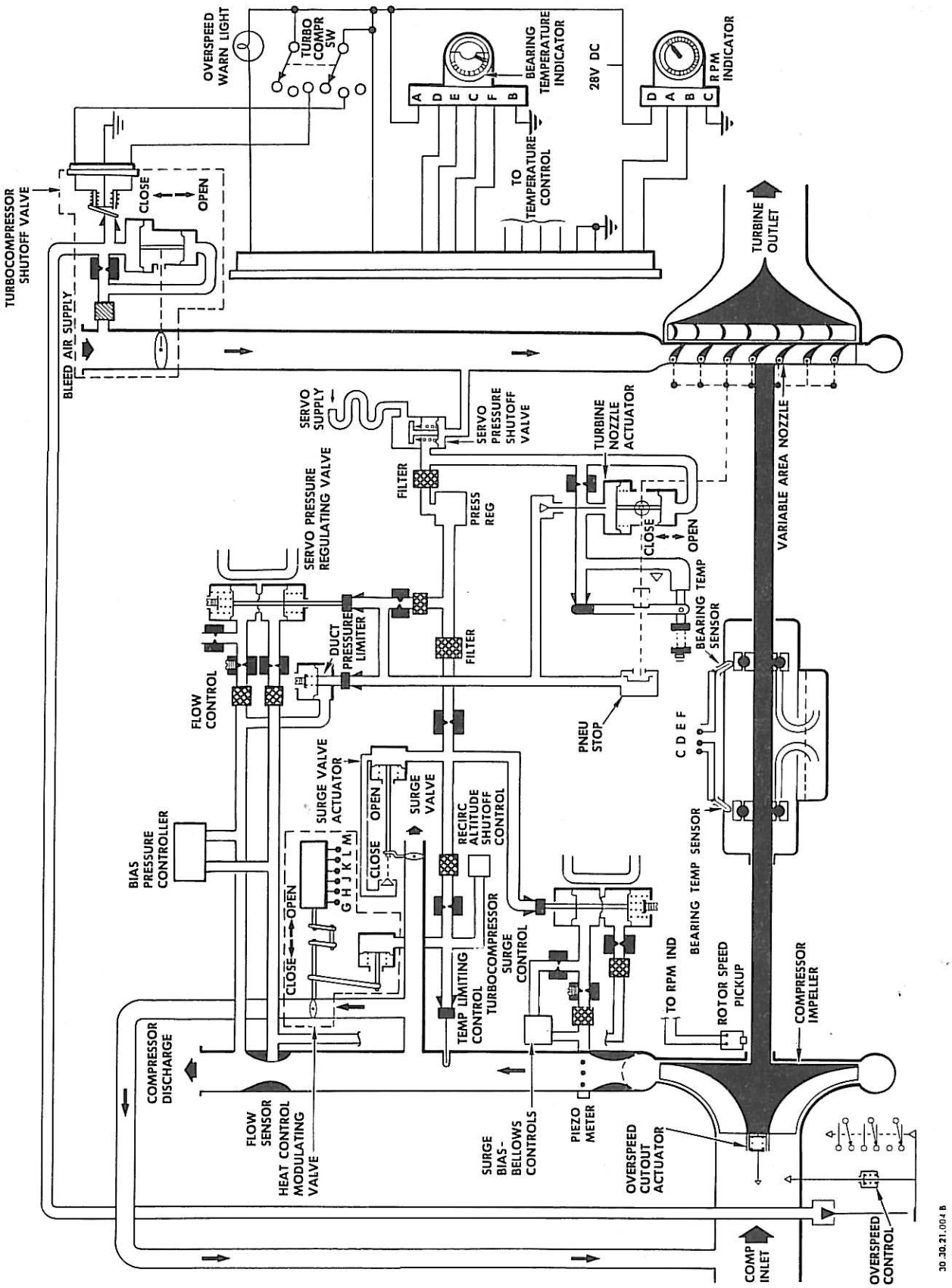


Turbocompressor Assembly
Figure 1 (Sheet 1 of 2)

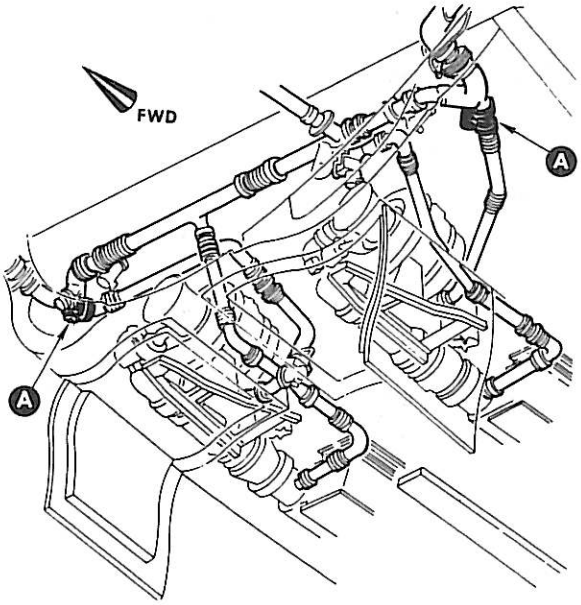


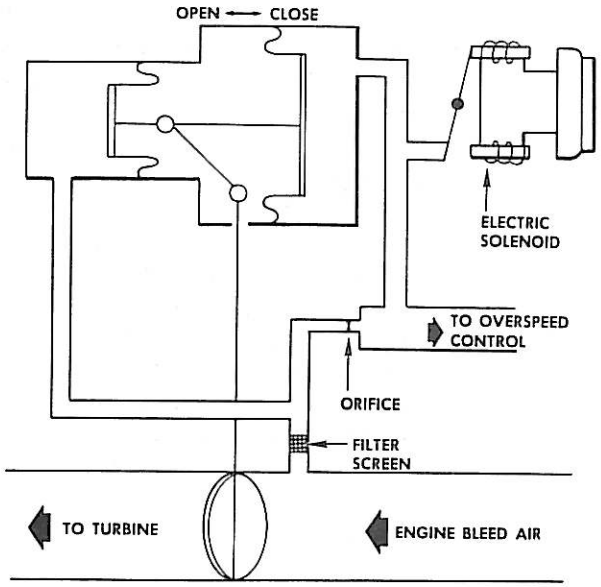


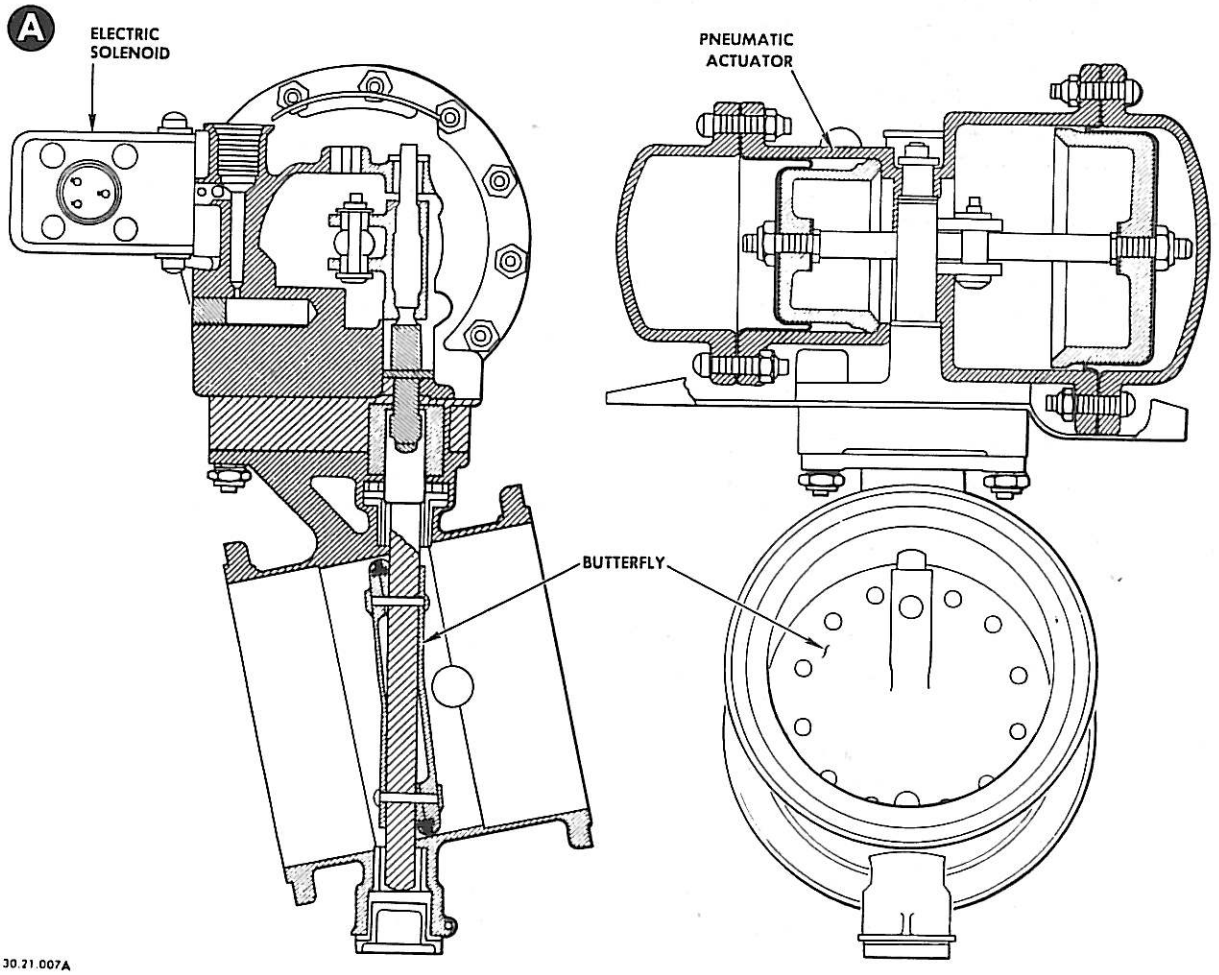
TURBOCOMPRESSOR



Turbocompressor Operational Schematic
Figure 2


FWD
A
A


OPEN
CLOSE
ELECTRIC SOLENOID
TO OVERSPEED CONTROL
ORIFICE
FILTER SCREEN
TO TURBINE
ENGINE BLEED AIR


A
ELECTRIC SOLENOID
PNEUMATIC ACTUATOR
BUTTERFLY
30.30.21.007A

The electric solenoid contains an "on" winding and an "off" winding both connected to a common ground. When 28-volt dc power is applied to the "on" winding through the closed contacts of the turbocompressor AUTO-OFF-MAN ON switch, overspeed control and landing gear ground safety relay, the solenoid snaps a poppet into position over the servo passage vent and the shutoff valve opens. When the switch in the overspeed control trips, or the turbocompressor AUTO-OFF-MAN ON switch is moved to OFF, the circuit to the solenoid "on" winding is broken and 28-volt dc power is supplied to the solenoid "off" winding. Energizing the solenoid "off" winding unseats the solenoid poppet which vents the servo pressure and closes the shutoff valve. When the shutoff valve closes the turbocompressor shuts down. The use of two windings prevents loss of the turbocompressor operation upon any loss of electrical power. To change the valve position, the 28-volt dc signal must be removed from one winding and applied to the other. Thus, loss of electrical power to the energized winding will not change valve position.

3. Venturi Duct

A. Description.

The venturi duct is the turbocompressor outlet. The duct is constricted near the attachment to the piezometer ring on the transition outlet duct of the compressor. The outlet portion of the duct is flared and contains a flanged mounting surface for attachment of a surge valve. A sensing line to the flow control connects into the constriction. The piezometer ring is not physically a part of the venturi duct but functions with the venturi. The peizometer ring encircles the outlet duct over eight equally spaced holes into the bore. A sensing line connects the peizometer to the flow control and a side port tapped straight into the bore is connected to the pressure limiter control. The venturi duct is encompassed by a servo pressure reservoir.

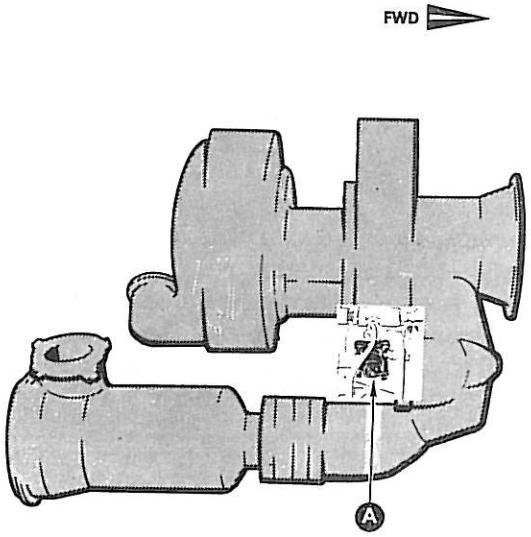
B. Operation.

Turbocompressor outlet flow is sensed by the flow control through pick-ups on the venturi duct. As outlet flow increases, throat pressure at the constriction decreases in relation to duct pressure sensed through the piezometer. The reduction in pressure is sensed by the flow control which, in turn, regulates servo pressure to the nozzle actuator. The nozzle actuator controls RPM to maintain the desired rate of flow. The servo pressure reservoir maintains a steady servo pressure source which stabilizes turbocompressor operation when the normal servo supply is subject to rapid pressure transients.

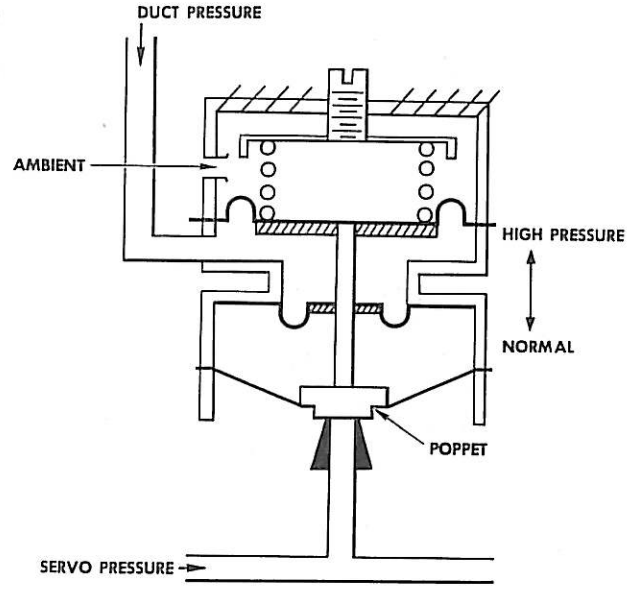
4. Pressure Limiter Control

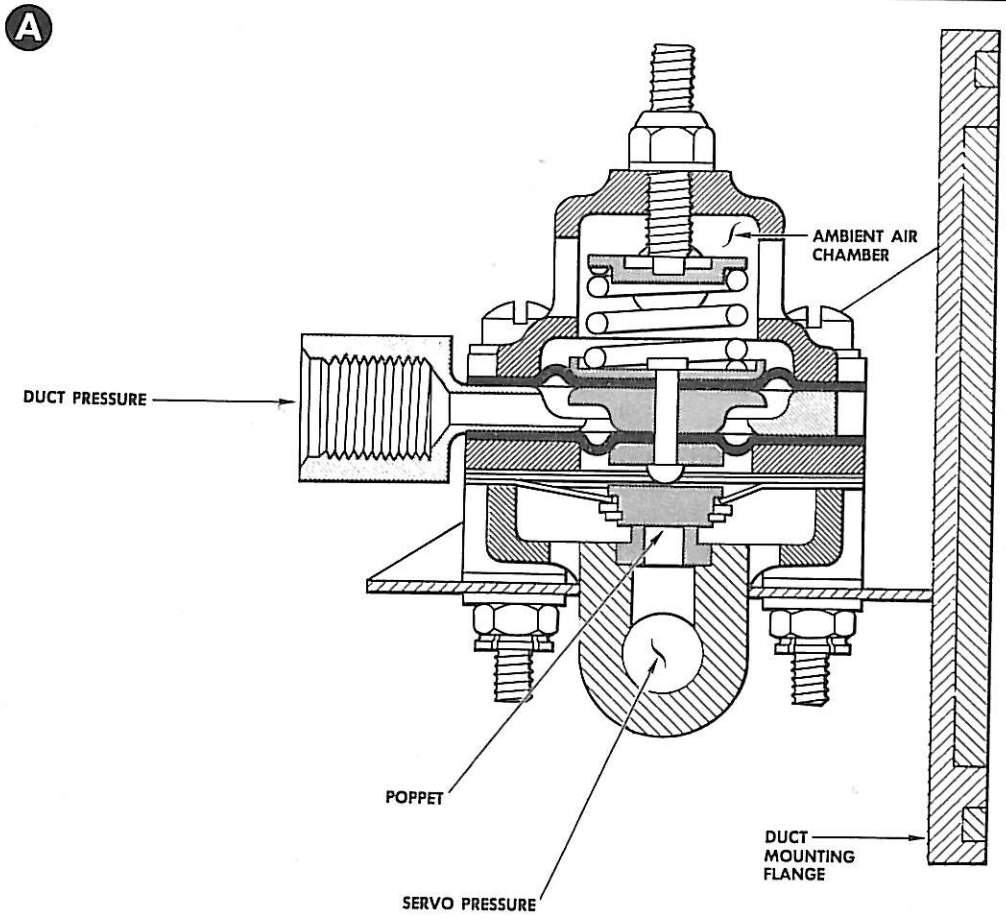
A. Description.

The pressure limiter control, shown on Figure 4, consists of a housing with a pressure sensing chamber and a diaphragm-operated poppet valve.



TURBOCOMPRESSOR





PRESSURE LIMITER CONTROL

22.30.21.068C

A sensing tube connects the central control chamber to the pressure pickup on the transition outlet duct near the piezometer ring. Servo tubing from the flow control to the pneumatic amplifier of the nozzle actuator is connected by a tee to the vent under the poppet. The diaphragm piston is spring-loaded toward the poppet "closed" position.

B. Operation.

The pressure limiter limits output pressure by controlling turbocompressor rpm. An increase in compressor outlet pressure, approaching maximum pressure, moves the piston and poppet away from the servo tube vent. The open poppet reduces servo pressure to the nozzle actuator which causes the nozzle vanes to move toward the closed position, thereby reducing rotor speed. Normal operating conditions permit the spring load to hold the poppet closed.

5. Turbocompressor Overspeed Control

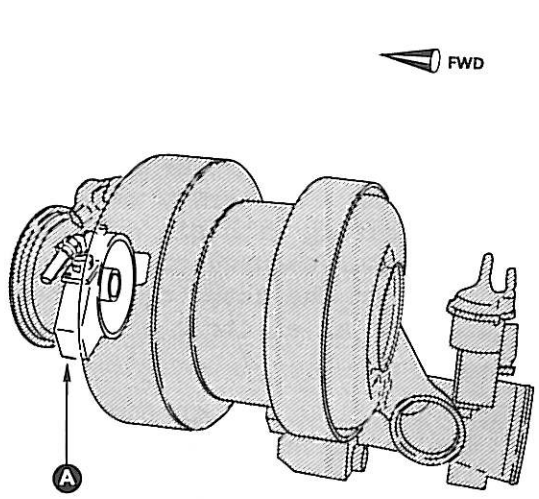
A. Description.

The overspeed control is an inlet-connecting duct with an overspeed switch, poppet and an actuating mechanism. The overspeed control is a part of the turbocompressor assembly and is illustrated on Figure 5.

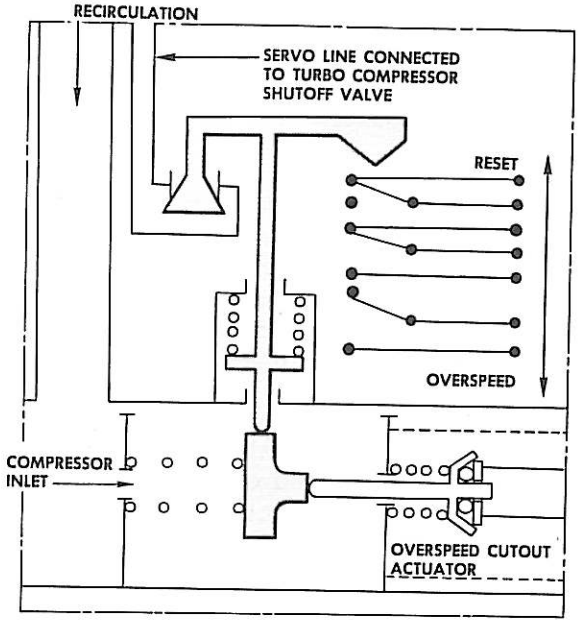
A connecting duct joins the ram air inlet to the compressor inlet and contains a side port, connecting with the heat control modulating valve in the recirculation duct. The overspeed tripping mechanism of the control is held in line with the actuator pin of the overspeed cutout actuator on the rotor shaft. The switch is wired to the turbocompressor shutoff valve solenoid, to the turbocompressor AUTO-OFF-MAN ON switch, and to the overspeed indicating light. The poppet is held in the closed position mechanically and is spring-loaded to open the turbocompressor shutoff valve servo vent line to ambient when the cutout actuator trips the overspeed control.

B. Operation.

The overspeed control is a safety device that provides means for shutting down the turbocompressor when rotor speeds exceed a preset maximum rpm. Normal turbocompressor operation is provided by a closed circuit through the switch, supplying 28-volt dc power to the "on" winding of the turbocompressor shutoff valve on-off solenoid. When rotor rpm becomes excessive, the overspeed cutout actuator trips the overspeed control, actuating the switch and opening the poppet. The open poppet vents servo air supply to the large actuator chamber of the shutoff valve, closing the valve. When the switch actuates, the circuit to the solenoid "open" winding is broken, a circuit to the overspeed indicating light is made and 28-volt dc power is supplied through a third circuit to the solenoid "close" winding opening the solenoid poppet. The open solenoid poppet also vents the large actuator chamber closing



TURBOCOMPRESSOR



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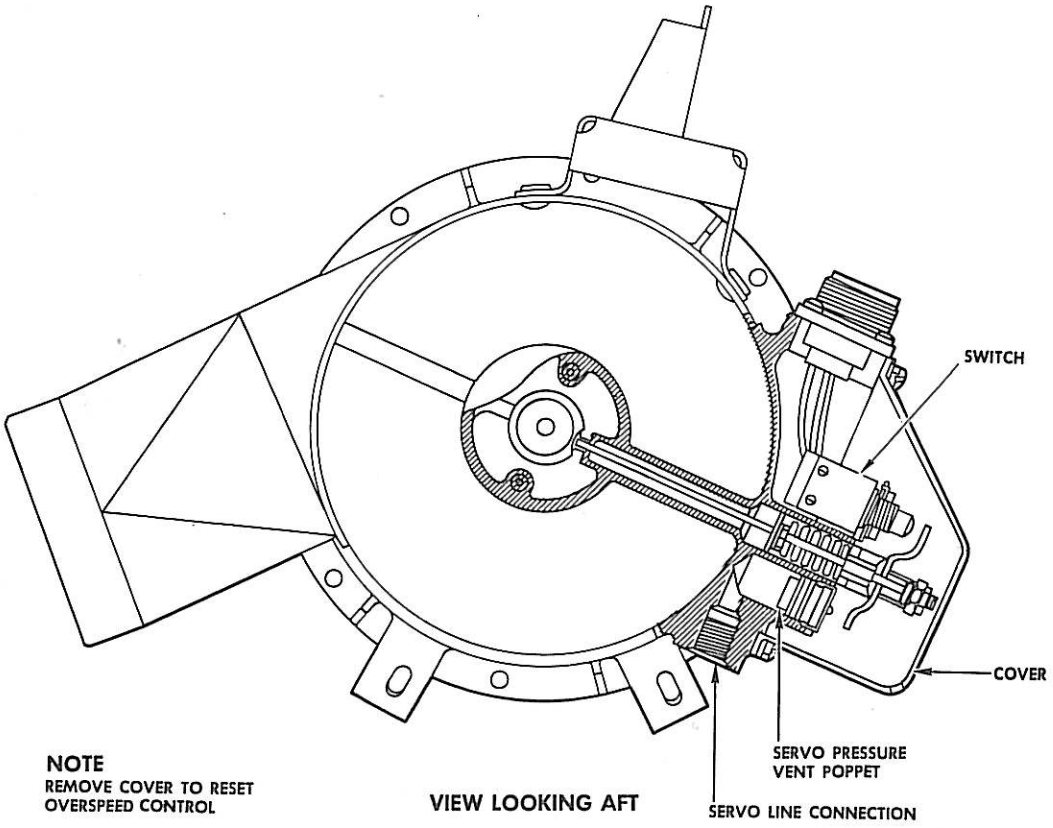


NOTE
REMOVE COVER TO RESET OVERSPEED CONTROL

VIEW LOOKING AFT

TURBOCOMPRESSOR OVERSPEED CONTROL

22.30.21.070 B

the valve. The turbocompressor is then inoperative until the overspeed control is reset manually.

6. Heat Control Modulating Valve

A. Description.

The heat control modulating valve, illustrated on Figure 6, consists of a pneumatic actuator, an electric actuator, and a butterfly valve. The pneumatic actuator consists of an actuator housing with six ambient vents, an actuator shaft, a spring-loaded piston secured to the shaft, and a diaphragm which separates the piston from the actuator chamber in the cap. The electric actuator consists of an electric motor, gear train, and a positioning potentiometer.

The pneumatic actuator shaft is pinned to a slotted cam through a cam roller. The slotted cam is splined to the valve shaft which extends through the support mounting flange of the pneumatic actuator. The electric actuator is splined to a drive lever which holds an override cam against the pneumatic actuator cam on the valve shaft.

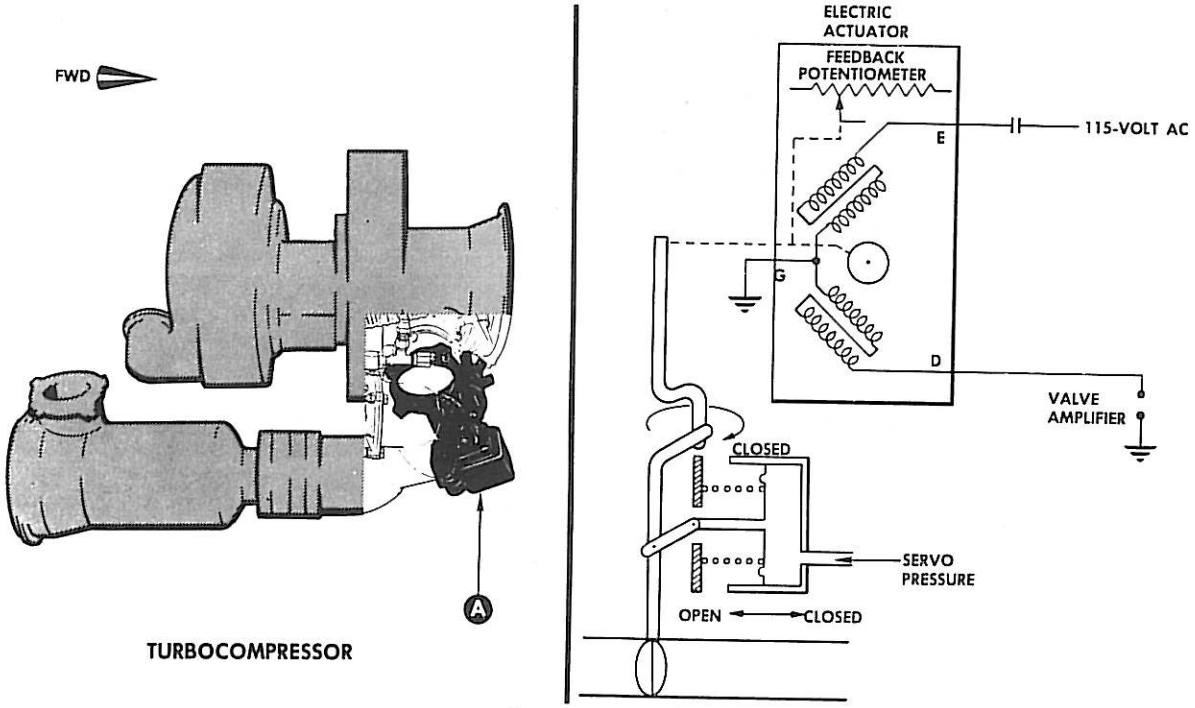
A line connects the pneumatic actuator chamber to the servo line between the surge control and pressure regulator. A tee in the servo line connects into the temperature limiter control. The heat control modulating valve is held in the normally closed position by the spring load on the actuator piston.

B. Operation.

The heat control modulating valve operations can be ascertained by following the schematic on Figure 6. The valve controls the flow of recirculation air through the bypass return to the compressor inlet. Servo pressure supplied to the pneumatic actuator works against the spring load to open the valve. The servo pressure against the diaphragm causes the piston to move. This piston movement is translated from a linear movement of the actuator shaft to a rotational movement of the valve shaft by the cam and cam roller. As the actuator shaft moves out from the actuator housing the cam is forced to turn by the cam roller moving in the cam slot. The extent of the cam turning is limited by the position of the electric actuator drive lever.

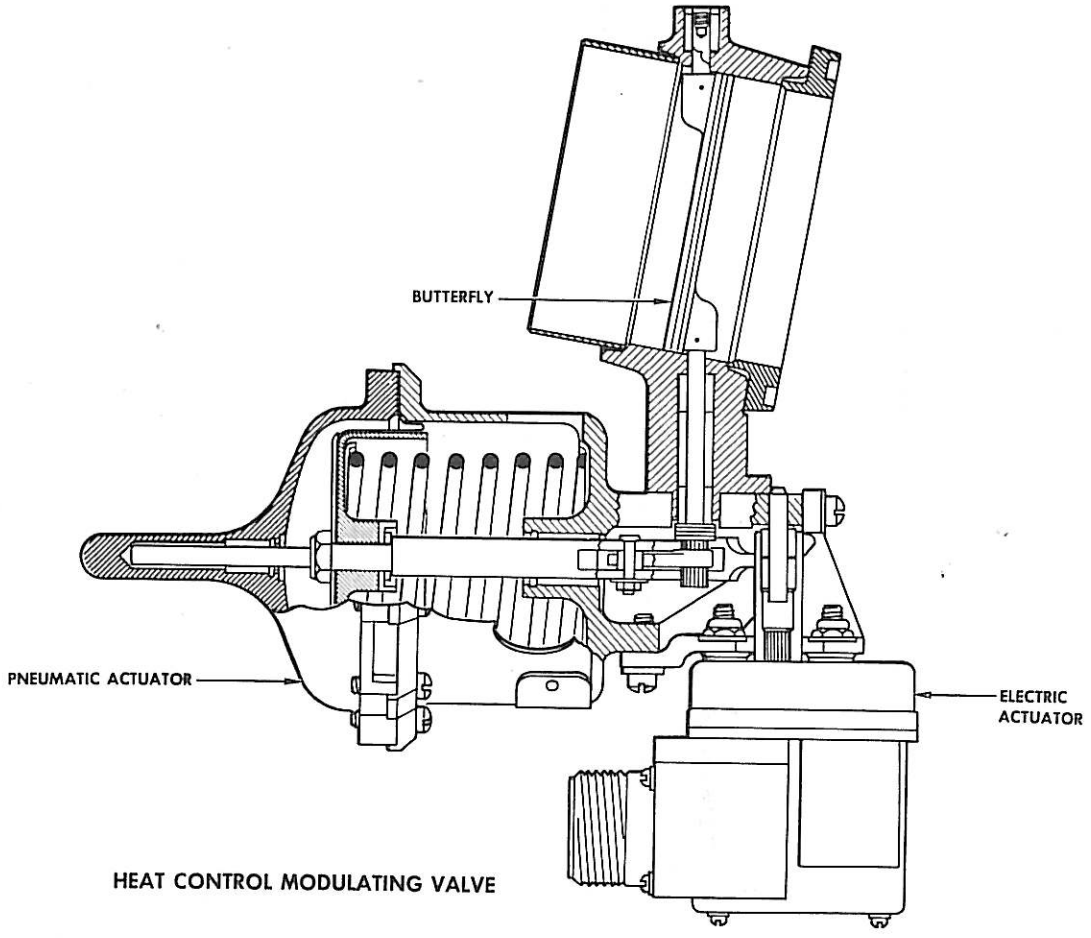
When the electric actuator is energized to the valve "closed" position its drive lever loads the outside of the cam forcing the valve closed against any control pressure in the pneumatic actuator. When the electric actuator is energized toward the valve "open" position the butterfly rotates toward the open position due to servo pressure in the pneumatic actuator.

The electric actuator is controlled by the temperature control system. Termination or interruption of control voltage to the electric actuator will permit servo pressure to open the valve only if the actuator is in the open position. The electric actuator, by rotating the override cam, allows the pneumatic actuator to open the valve only as much as the override cam permits. Thus, the temperature control system modulates the valve during automatic operation.



TURBOCOMPRESSOR

A



HEAT CONTROL MODULATING VALVE

22.30.21.065C

A temperature limiting control which senses compressor outlet air temperature, operates a poppet valve to vent servo pressure to atmosphere at a preset compressor outlet air temperature. With the servo pressure vented, pressure is reduced at the pneumatic actuator diaphragm, thus moving the butterfly towards the closed position even though the electric actuator is positioned to permit the butterfly to remain in the open position.

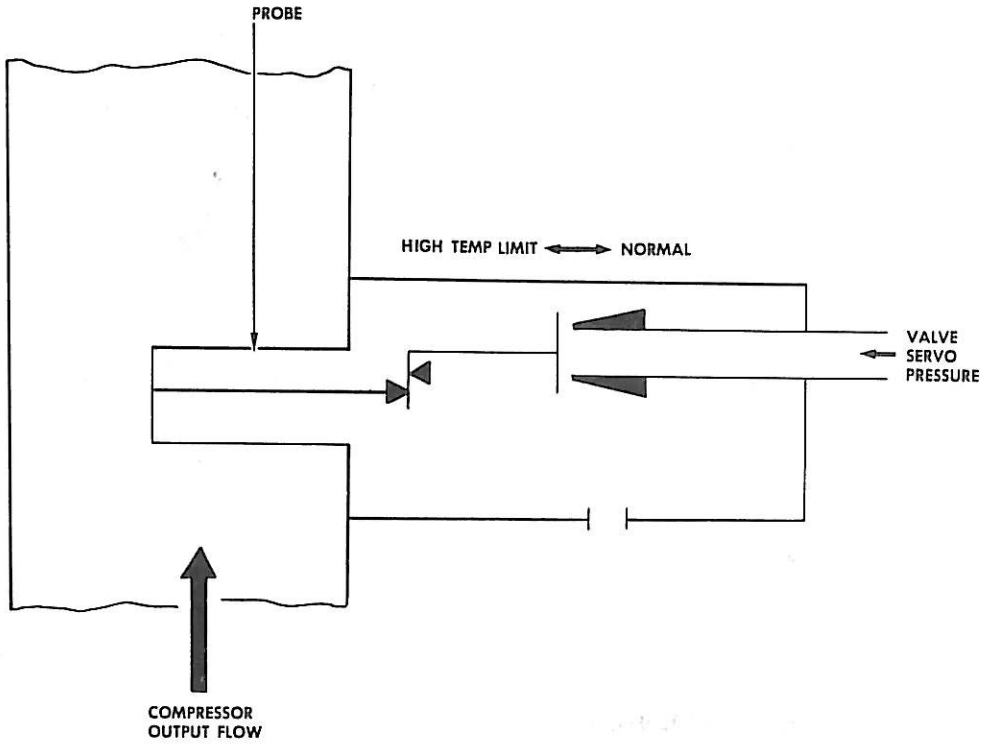
7. Heat Recirculation Temperature Limiter Control

A. Description.

The temperature limiter control, shown schematically on Figure 7, consists of a sensing probe and a poppet valve. The probe is placed in the transition outlet duct between the compressor discharge and bypass ports. A servo line connected to the limiter control, and closed by the control poppet, is connected into the servo line from the pressure regulator to the heat control modulating valve.

B. Operation.

The control vents valve servo pressure to ambient when the temperature of the compressor discharge air exceeds a set level. Increases in the compressor discharge air temperature are sensed by an Invar rod in the probe which expands causing a rocker arm to open the poppet. The



22.30.21.074C

open poppet permits servo air to escape, permitting the heat control modulating valve to move toward the closed position, thereby limiting turbocompressor recirculation heating.

8. Recirculation Altitude Shutoff Control

A. Description.

The recirculation altitude shutoff control, shown on Figure 8, consists essentially of a bellows operated poppet valve. A servo pressure line from the heat control modulating valve is connected to the control on one side of the poppet valve; the opposite side of the control is vented to ambient.

B. Operation.

When the airplane exceeds a predetermined altitude, the shutoff control bellows expands and actuates the poppet valve to the open position. Control servo pressure is vented to ambient through the open poppet valve to insure that the turbocompressor heat control modulating valve remains closed; additional heating (by recirculating air through the turbocompressor) is not required above the predetermined altitude.

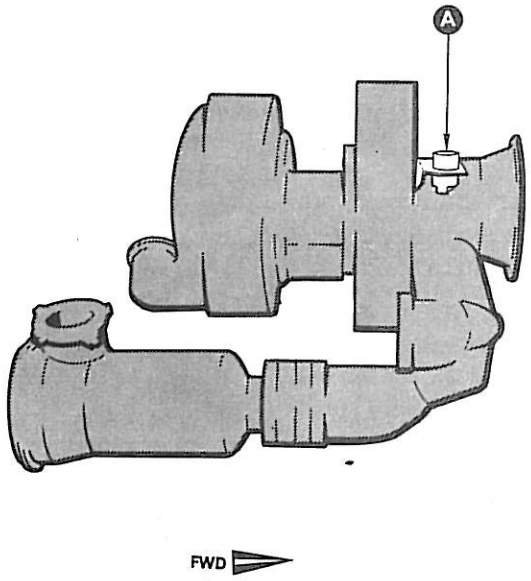
9. Pressure Regulator and Relief Valve

A. Description.

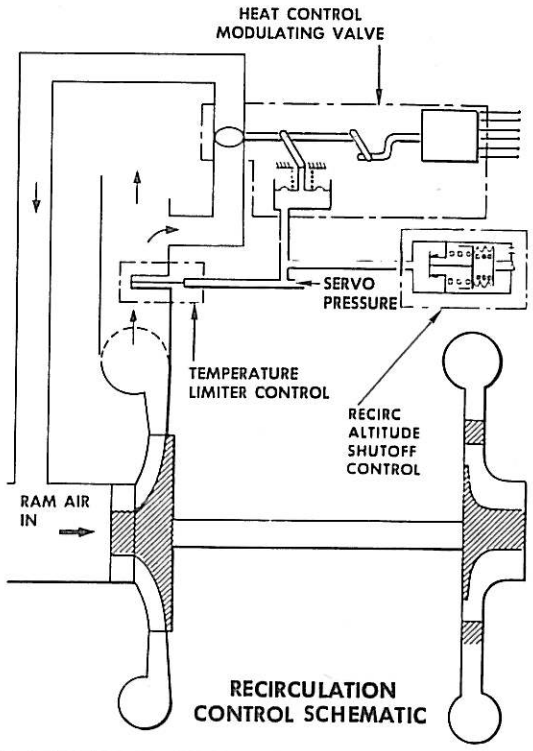
The pressure regulator and relief valve, shown on Figure 9, consists of a filter, a diaphragm-operated sleeve valve and a spring-loaded relief poppet. The pressure regulator and relief valve is mounted on the compressor inlet above the overspeed control box where it connects the servo pressure shutoff valve outlet to the flow, surge, and recirculation control servo tubes.

B. Operation.

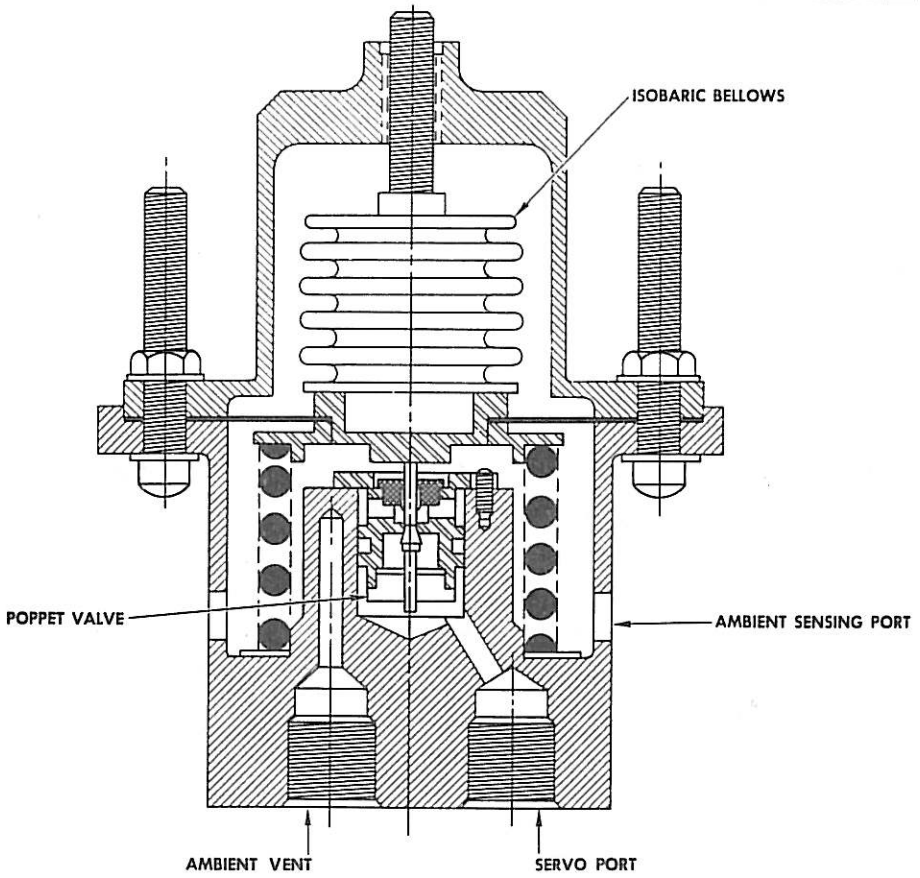
Cooled servo pressure from the servo pressure shutoff valve enters the regulator through a spring-loaded filter which insures the passage of clean servo air. If the filter screen becomes clogged the servo pressure will bypass the filter by forcing the screen to compress the spring. The filtered air passes through a cone shaped valve seat and through the metering sleeve to the diaphragm chamber. Increases in servo pressure cause the diaphragm to move the sleeve toward the cone seat thus regulating the servo supply pressure. The poppet will unseat at pressures slightly higher than regulated pressure thereby regulating servo supply at a higher level by bleeding excess pressure to ambient. The poppet valve relieves excess pressure thereby maintaining a maximum servo pressure limit.



TURBOCOMPRESSOR



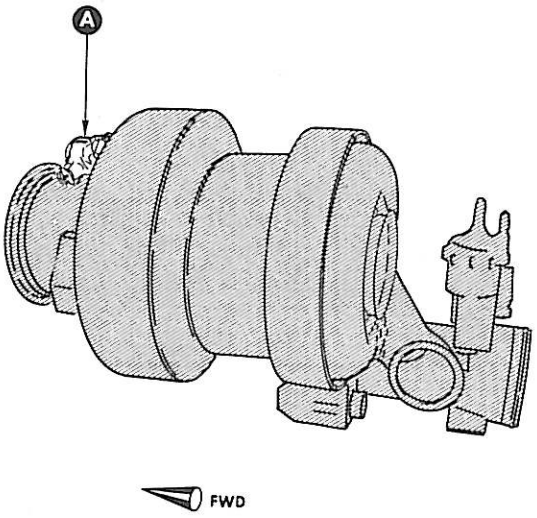
RECIRCULATION
CONTROL SCHEMATIC



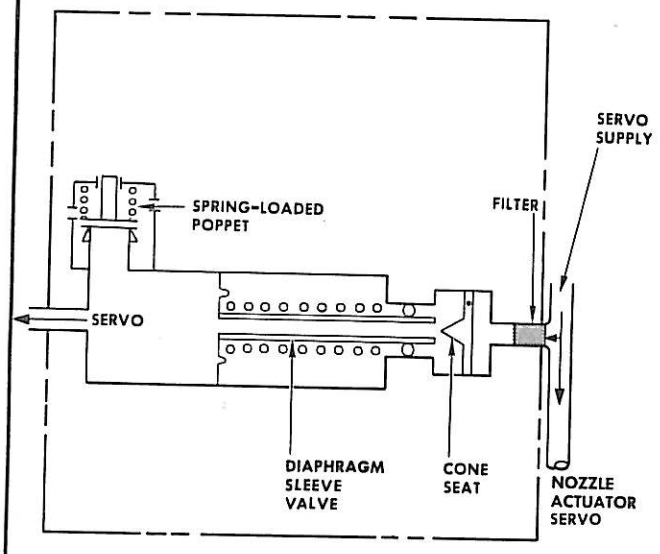
22.35.21.207 B

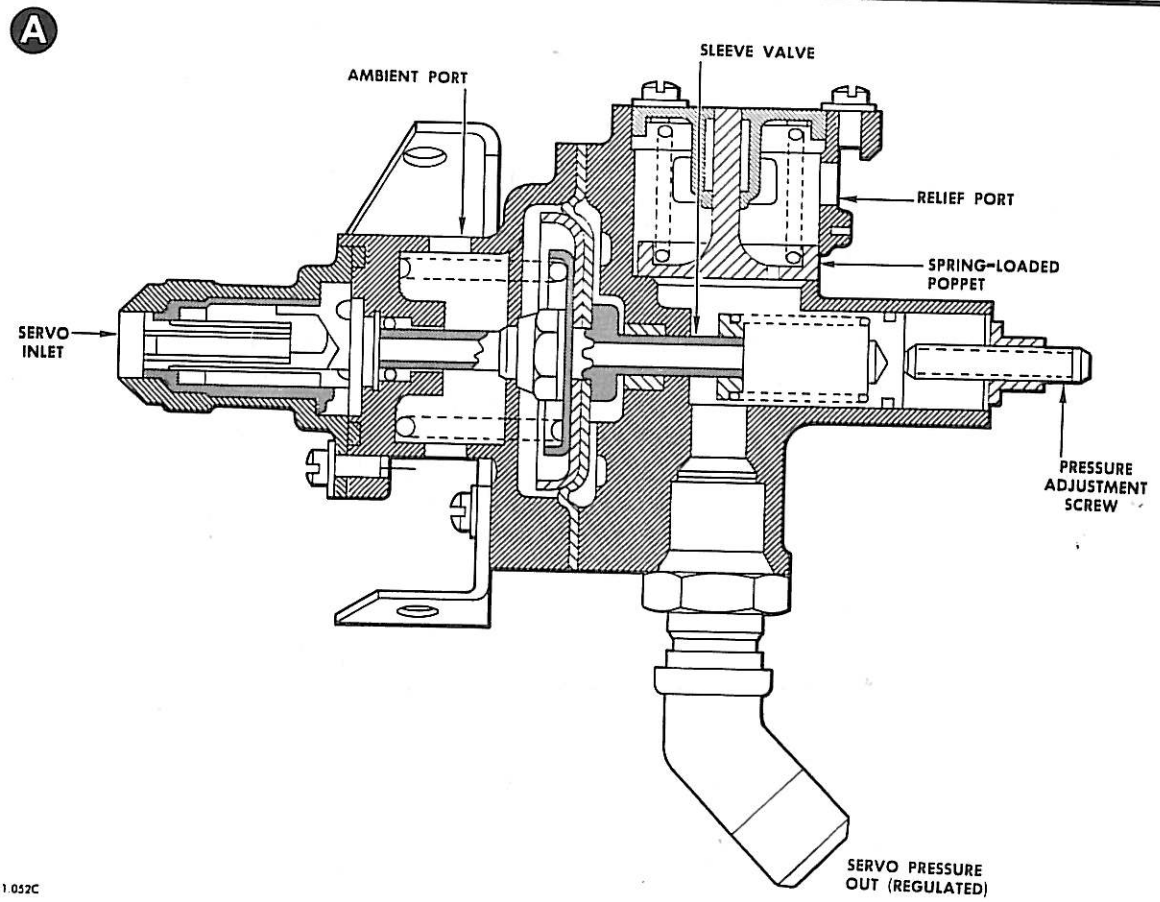
RECIRCULATION ALTITUDE SHUTOFF CONTROL

Recirculation Altitude Shutoff Control
and Control Schematic
Figure 8



TURBOCOMPRESSOR





22.30.21.052C

10. Turbocompressor Surge Control

A. Description.

The turbocompressor surge control, shown on Figure 10, consists of a housing with diaphragm-separated chambers containing spring-loaded pistons. Two additional diaphragms are held to the pistons and the pistons are linked to a poppet valve. The lower chamber is vented to ambient through an orifice connected to the bias altitude control. The lower chamber is also connected through an adjustable orifice to a sensing line from the bias altitude control and piezometer. The upper chamber is connected to a sensing line from the venturi. The poppet is held over a vent on one leg of a tee which is in the servo line from the pressure regulator to the surge valve.

B. Operation.

The surge control senses compressor discharge weight flow and pressure, and controls the servo pressure supply to the surge valve. Pressure within the duct at the piezometer is normally greater than the pressures picked up at the venturi. The duct pressure is supplied to the control chamber (lower chamber) which is spring-loaded toward the "puppet open" position. Venturi pressure which varies with weight flow and pressure, is supplied to the control chamber (upper chamber) which is spring-loaded toward the "poppet closed" position. Duct pressure is greater than venturi pressure during normal operating conditions, thus the poppet is held closed. With the poppet closed, sufficient servo pressure is supplied to the surge valve to hold the valve closed. Should compressor flow approach surge conditions, the difference between duct and venturi pressure decreases to permit the venturi pressure within the surge control to open the poppet. The open poppet vents surge valve servo pressure thus permitting the surge valve to open.

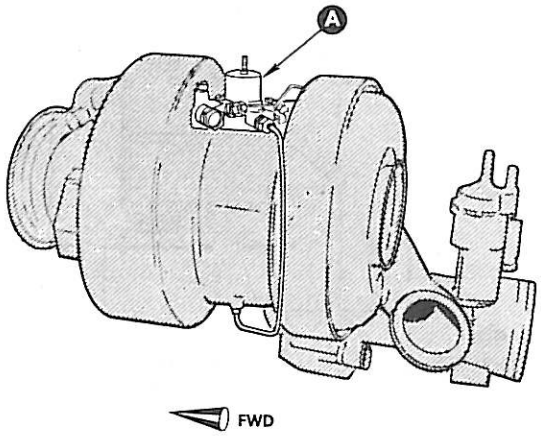
11. Turbocompressor Surge Valve

A. Description.

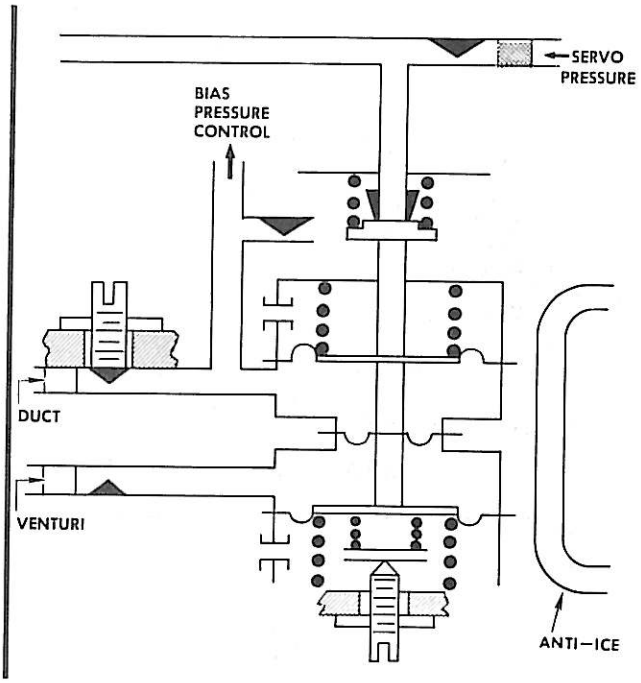
The turbocompressor surge valve, shown on Figure 11, consists of a pneumatic actuator linked to a butterfly valve. A servo pressure line connects a poppet valve and the surge valve actuator chamber to the surge control. The diaphragm operated piston within the valve is spring-loaded toward the valve open position. The poppet valve is spring-loaded in the closed position and is mounted with its actuating pin in line with the surge valve actuator shaft.

B. Operation.

The surge valve is a safety device which opens to prevent compressor surging. Compressor surge occurs when compressor outlet weight flow decreases below preset limits. Servo pressure from the surge control holds the surge valve closed for normal operation. A decrease in servo pressure allows the spring force to open the surge valve which vents a portion or all of the compressor discharge air to ambient, thereby creating an increase in weight flow through the compressor.



TURBOCOMPRESSOR



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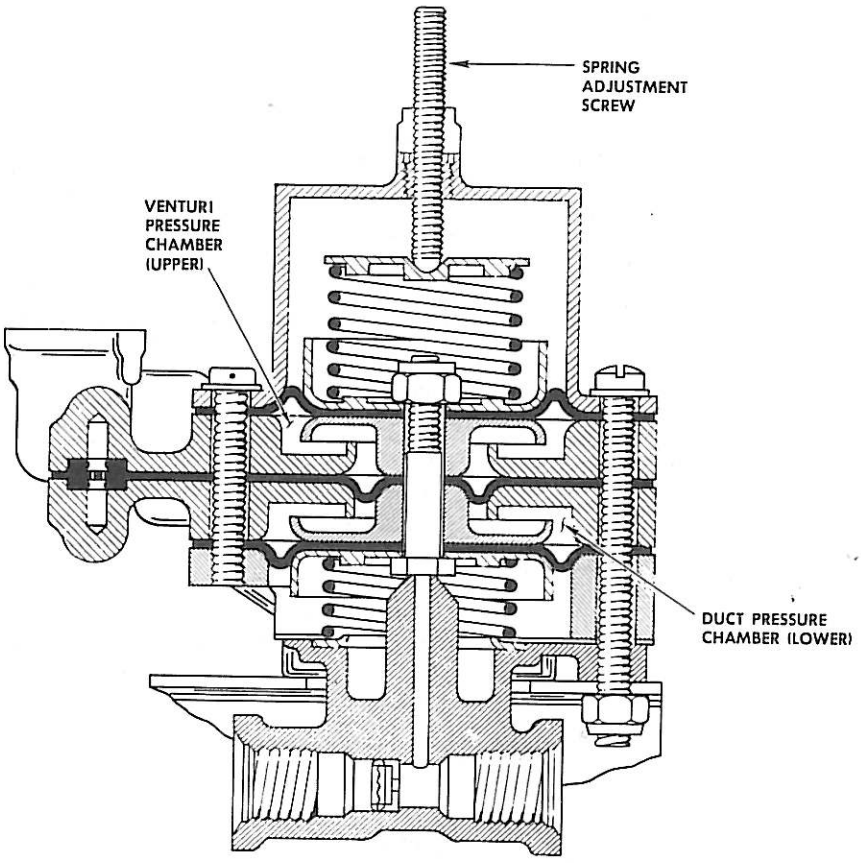
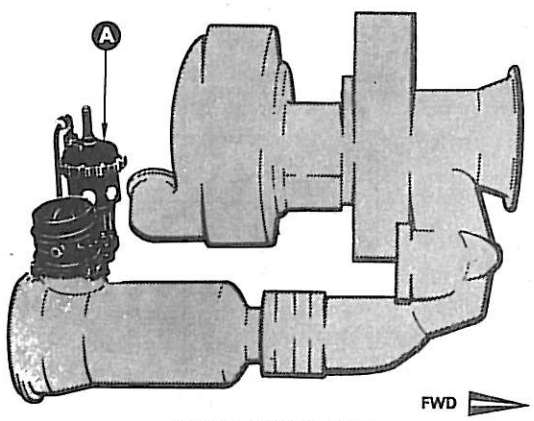
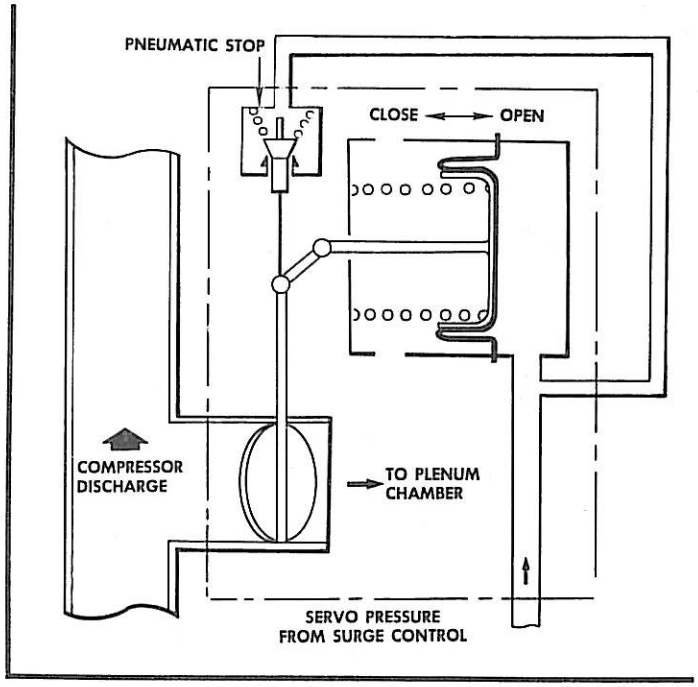


TURBOCOMPRESSOR SURGE CONTROL

22.30.21.081B



TURBOCOMPRESSOR



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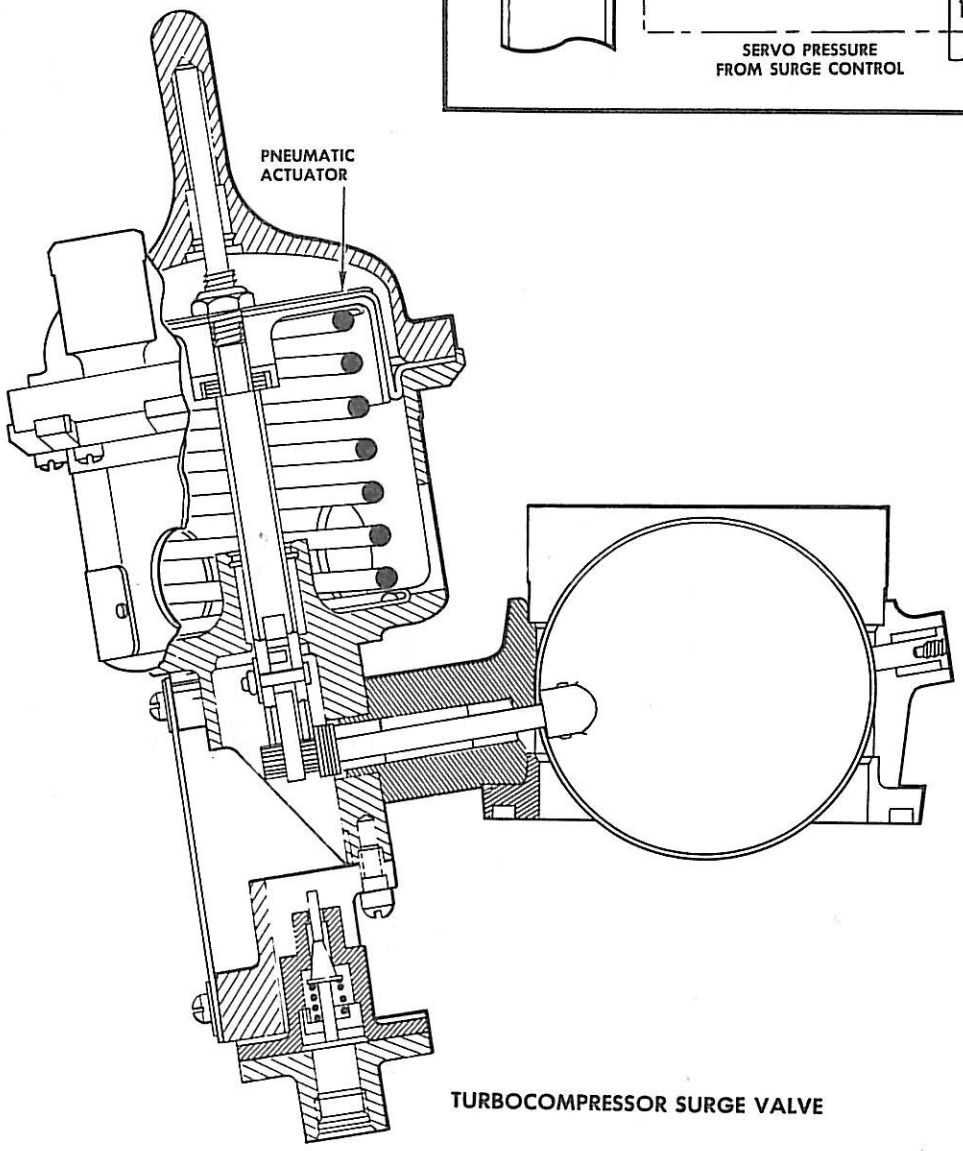
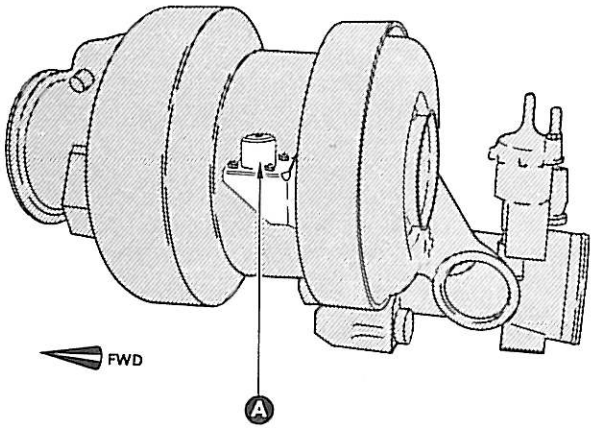
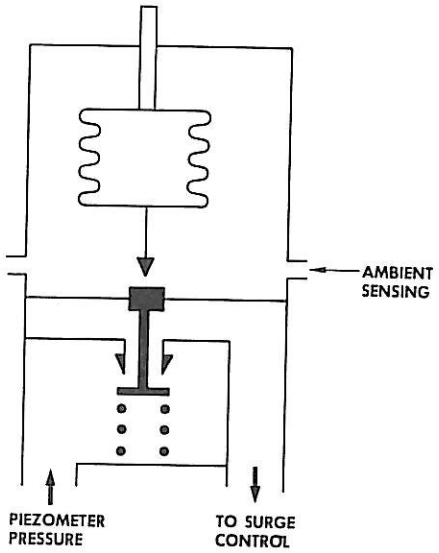


TURBOCOMPRESSOR SURGE VALVE

22.30.21.064D



TURBOCOMPRESSOR



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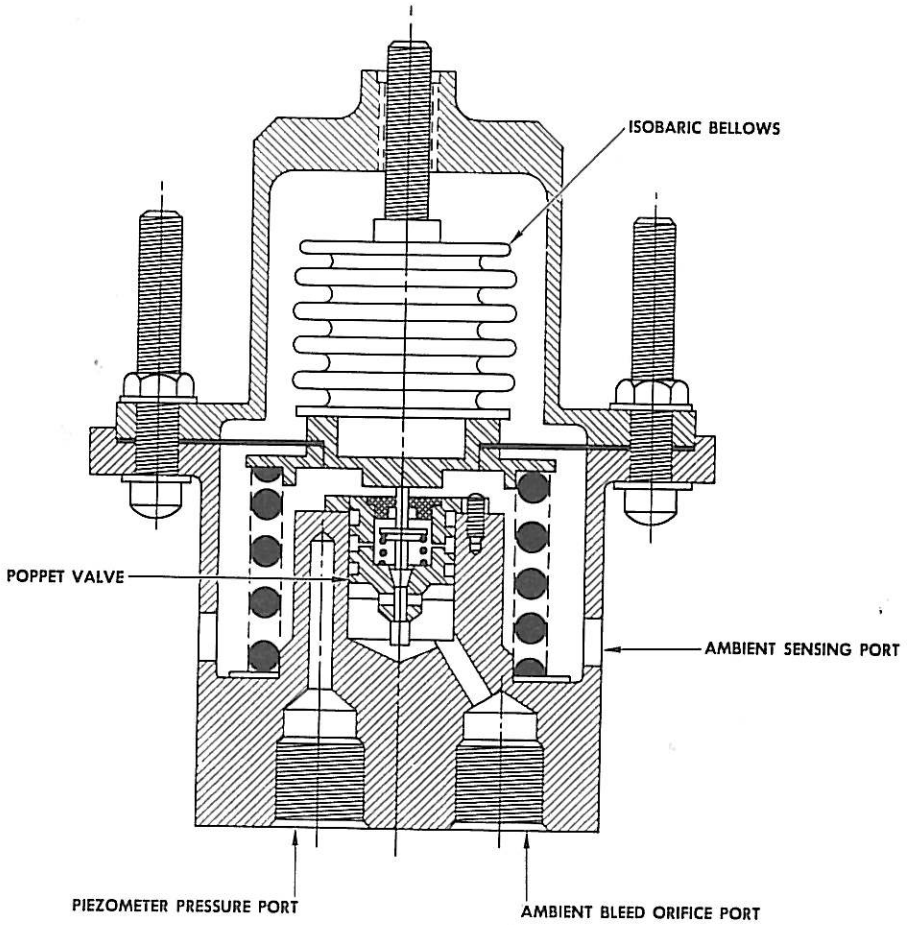

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BIAS ALTITUDE CONTROL

The poppet valve actuates when the surge valve approaches the closed position. The poppet valve, when open, bleeds off servo pressure to maintain the minimum servo pressure required to hold the surge valve closed. Action of the poppet valve permits the surge valve to respond immediately to signals from the surge control.

12. Bias Altitude Control

A. Description.

The bias altitude control, shown on Figure 11A, consists essentially of a bellows operated poppet valve. A pressure line from the piezometer is connected to the bias control on one side of the poppet valve and a surge control sensing line with fixed ambient bleed is connected to the opposite side.

B. Operation.

The bias altitude control permits piezometer pressure to bypass an adjustable orifice of the surge control until the airplane exceeds the pressure altitude setting of the bias control. Below this altitude setting, maximum piezometer pressure is available to signal for a closed surge valve. When the airplane exceeds the pressure altitude setting of the bias control, the poppet valve closes forcing piezometer pressure through the adjusted orifice and into the surge control.

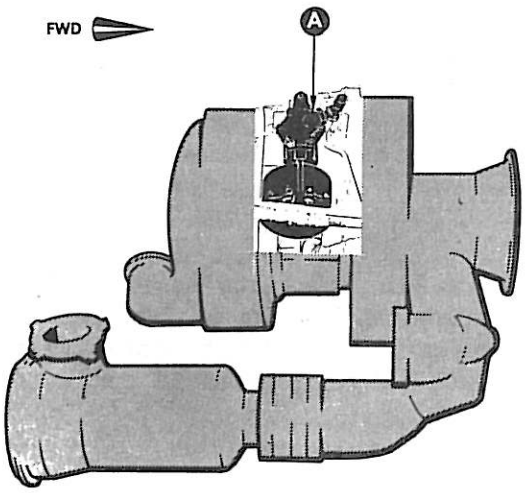
13. Turbocompressor Nozzle Actuator

A. Description.

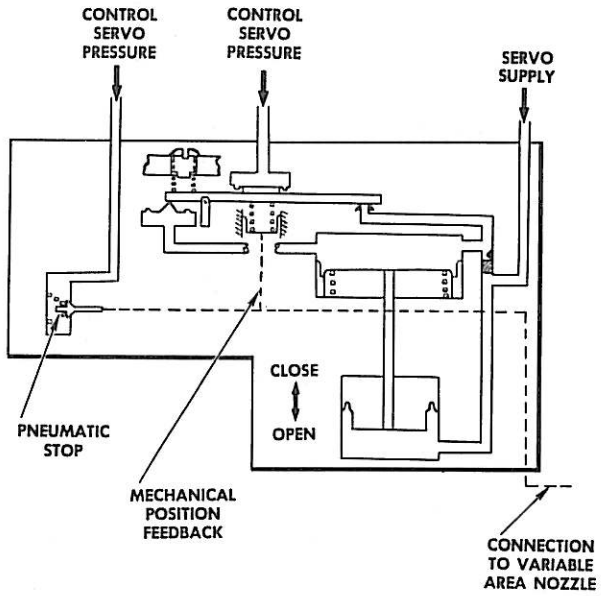
The turbocompressor nozzle actuator, illustrated on Figure 12, consists of differential pistons in dual pressure chambers. The pistons are mechanically linked to the turbine nozzle vanes. A servo tube connects both actuator chambers to a source of servo pressure (engine bleed air). The servo tube to the actuator chambers is also connected to a vent that is restricted by a lever on the pneumatic amplifier. A second servo tube connects the flow control and pressure limiter control to the pneumatic amplifier. The diaphragm-operated pistons, connected by a common actuator shaft, are spring-loaded toward the nozzle vane closed position. The actuator shaft connects with the master nozzle vane shaft by a drive lever. A cam follower connects to the diaphragm-operated amplifier piston lever.

B. Operation.

Servo pressure supplied to both actuator chambers drives the large piston against the spring load to rotate the master nozzle vane toward the nozzle open position. Greater force on the larger diaphragm causes this movement. The master vane drives the other nozzle vanes by turning a ring gear to which each vane is meshed by a gear segment.



TURBOCOMPRESSOR



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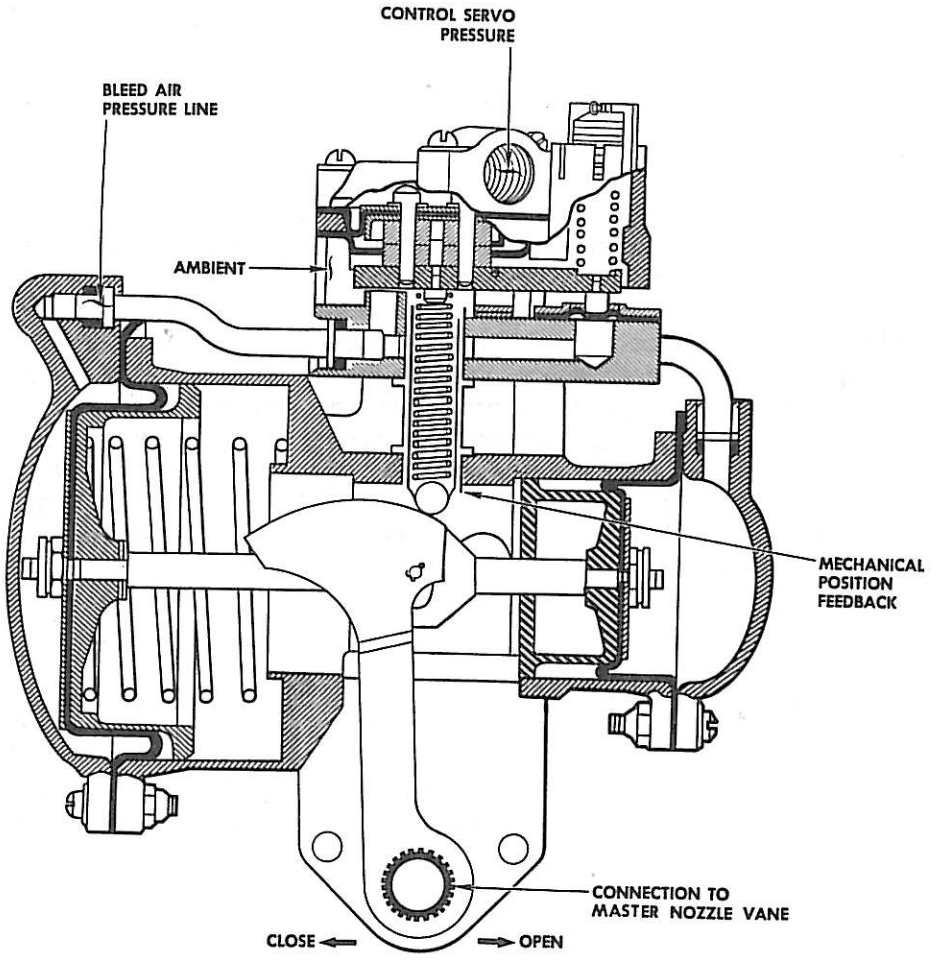

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Turbocompressor Nozzle Actuator
Figure 12

As the actuator moves toward the nozzle open position, a feed back cam drives a cam follower to increase spring tension under the amplifier piston lever. The increased spring force tends to move the piston against servo pressure supplied to the amplifier which would then move the amplifier lever away from a vent. The vent permits servo pressure in the large actuator chamber to escape, tending to close the nozzle vanes due to the pressure on the small diaphragm. The amplifier lever reaches an intermediate position that balances the pressure on the amplifier diaphragm with feedback spring tension determined by actuator position. The actuator balance is controlled by the servo pressure supply to the amplifier chamber, which in turn is subject to regulation by the flow and pressure limiter controls. The maximum pressure limit in the actuator is set by the poppet valve which bleeds off pressure to maintain the minimum pressure for the full-open nozzle condition. Servo control pressure is amplified by the larger actuating area of the diaphragm-operated piston in the amplifier. The controls affect rotor speed by bleeding off servo pressure which tends to close the nozzle vanes by opening the amplifier vent from the large actuator.

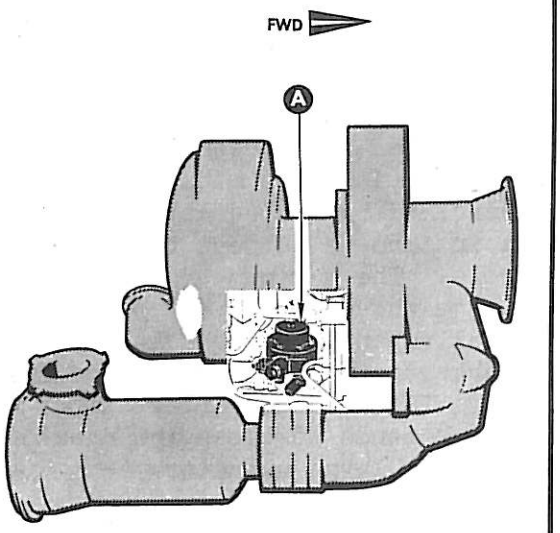
14. Turbocompressor Flow Control

A. Description.

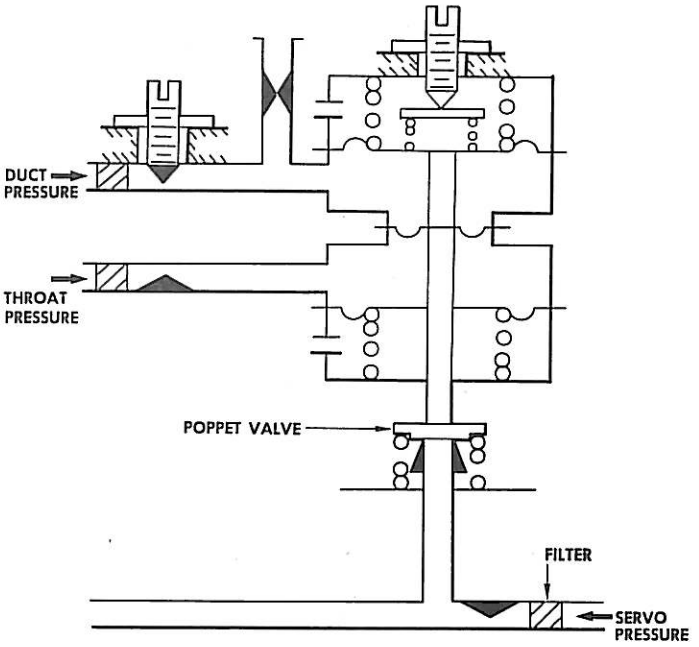
The turbocompressor flow control, illustrated on Figure 13, consists of a housing with diaphragm-separated chambers containing spring-loaded pistons. Two additional diaphragms are held to the pistons which are linked to a poppet valve. The upper or duct pressure chamber of the flow control is vented to ambient through a choked orifice and is also connected through an adjustable orifice to a sensing line from a piezometer ring upstream of the venturi. The lower or throat pressure chamber is connected to a sensing line from the constriction of the venturi duct. Both the venturi and piezometer sensing lines are connected to a bias pressure control. The poppet valve vents a portion of the servo pressure from the servo pressure regulator to atmosphere, thereby regulating the servo pressure between the pressure regulator upstream, and the pressure limiter control and nozzle actuator downstream.

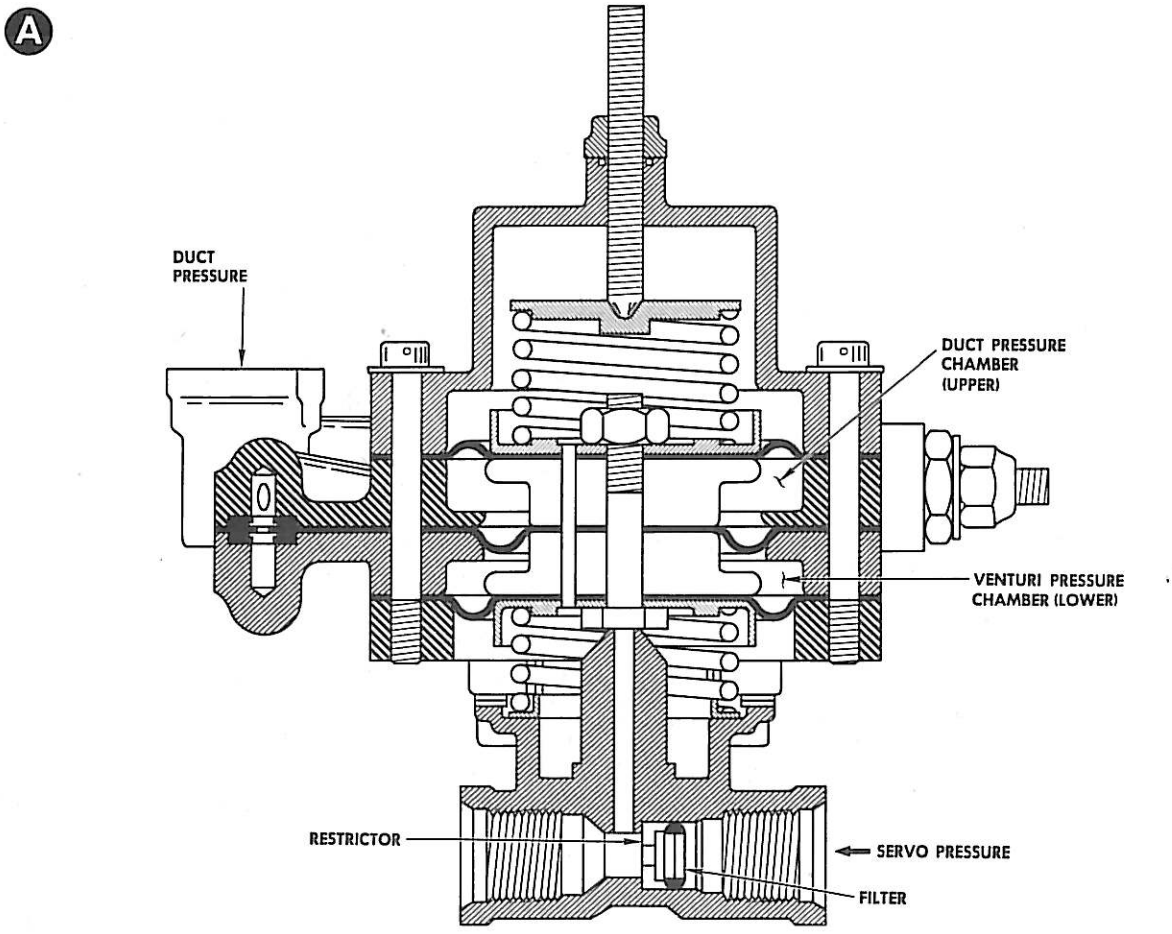
B. Operation.

The flow control senses turbocompressor output and limits the discharge flow by controlling rotor rpm. Pressure at the venturi throat decreases as flow increases. This pressure is supplied to the throat pressure chamber. A higher duct pressure from the piezometer pickup ring is supplied to the duct pressure chamber, tending to open the poppet. Normal operating conditions balance the opposing forces and hold the poppet in a partially open position. The fully open poppet will reduce servo pressure to the nozzle actuator amplifier which will cause the nozzle vanes to move toward the closed position, thereby reducing rotor speed.



TURBOCOMPRESSOR





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TURBOCOMPRESSOR FLOW CONTROL

15. Bias Pressure Control

The bias pressure control, shown on Figure 14, consists of a diaphragm operated piston and a poppet valve. The venturi and piezometer pressure sensing lines that lead to the flow control are connected into the bias control on opposite sides of the poppet valve. Ambient pressure opposes piezometer pressure across the control diaphragm. When ambient pressure exceeds duct pressure plus spring tension on the piston, the piston actuates the poppet valve and feeds piezometer pressure to the venturi sensing line. Biasing the flow control sensing pressure increases the turbocompressor output flow.

16. Cooling and Lubrication

The turbocompressor assembly incorporates air cooling and oil lubrication units, shown on Figure 15, to cool and lubricate the rotor shaft bearings. Two flexible ducts directed toward the compressor inlet end of the assembly serve as bearing cooling air inlets. The cooling air is pulled in over the inner bearing housing by air fans on the rotor and impeller ends of the rotative assembly and discharged along the inner turbine housing. The bearings are lubricated by oil wicks fed from the oil sump. The oil is deposited on both ends of a flared spacer which is mounted between the bearings. The oil is thrown outward from the flared spacers and is drawn through the bearings by the pumping action of the oil impellers.

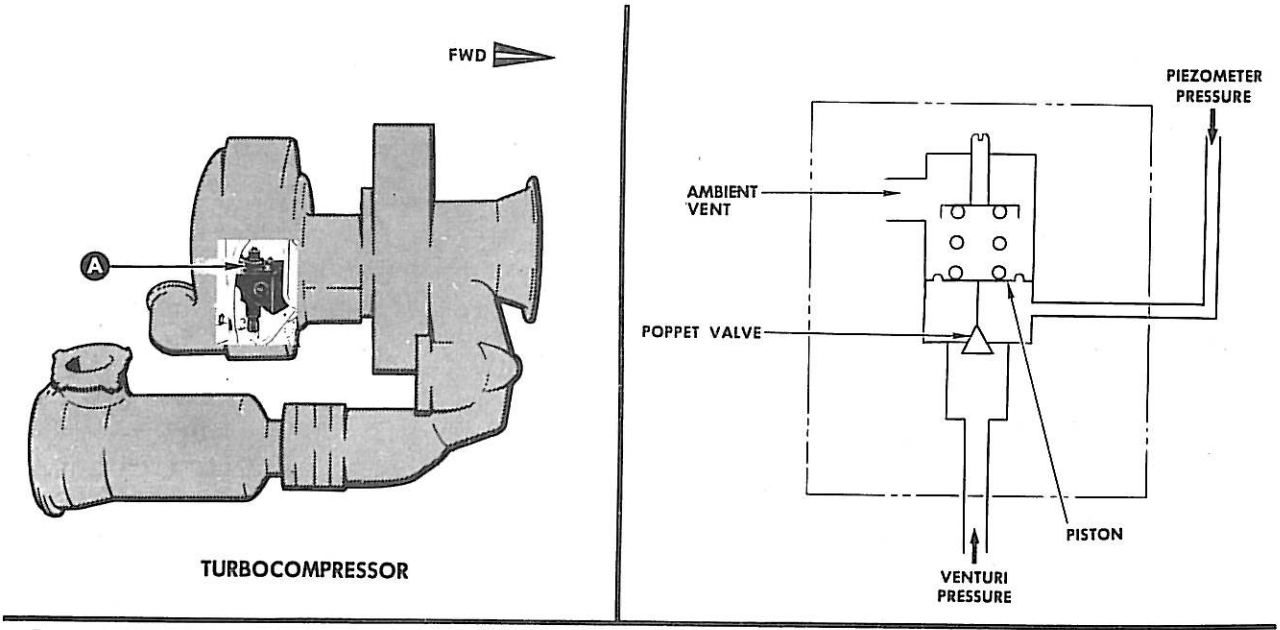
17. Turbocompressor Bearing Temperature Indicator

A. Description.

Turbocompressor bearing temperature indicators, shown on Figure 16, for the cabin and flight compartment pressurization subsystems are located on the flight engineer's control panel. The indicators monitor the temperature of the two bearings on each turbocompressor and indicate the temperature of the hottest bearing.

B. Operation.

A temperature probe is mounted next to the forward and aft bearing of the rotor. They contain thermistors that decrease in electrical resistance as temperature increases. The two probes are connected to the transistorized control circuit housed in the back of the indicator on the flight engineer's control panel. The position of the temperature indicating needle is determined by the probe with the least resistance -- or highest temperature. The temperature indicator dial has a range of 65 to 200 degrees C (149 to 392 degrees F). The maximum safe operating temperature is indicated by a red mark on the dial at 121 degrees C (250 degrees F).



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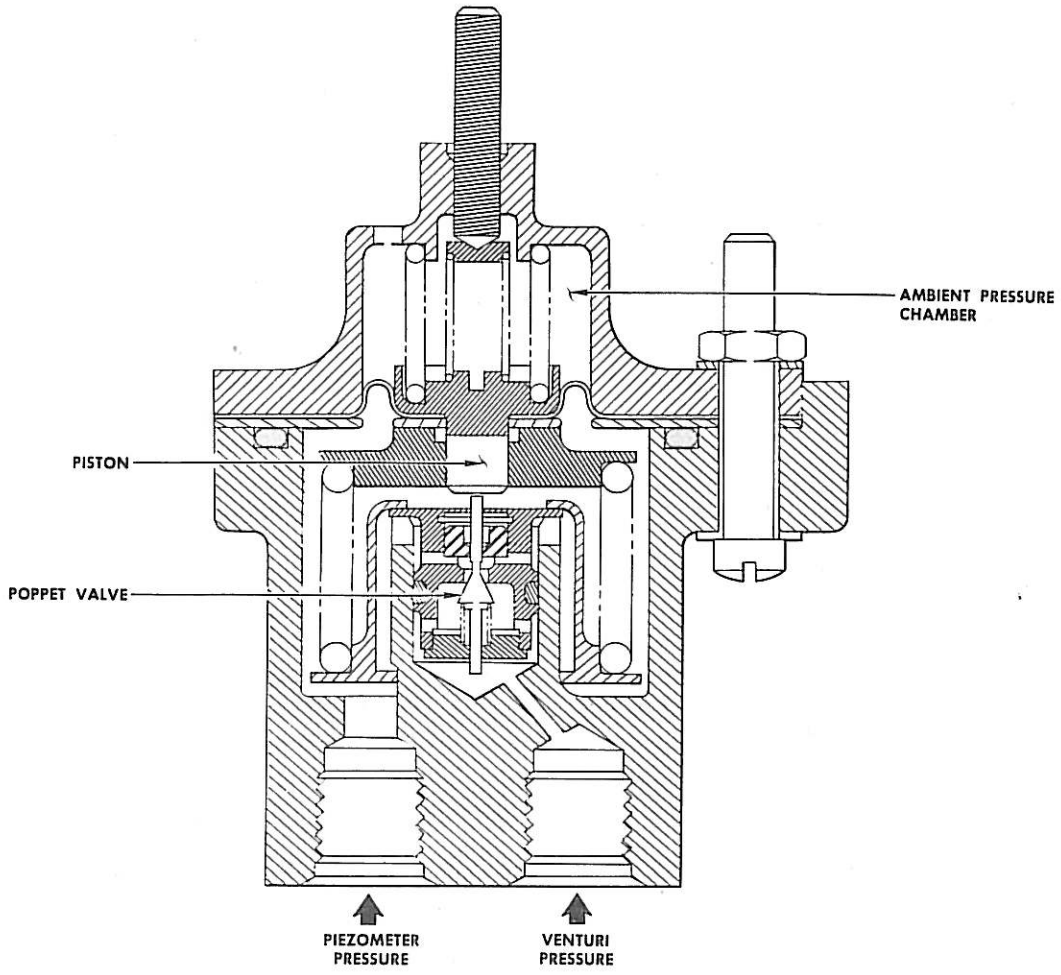
BIAS PRESSURE CONTROL



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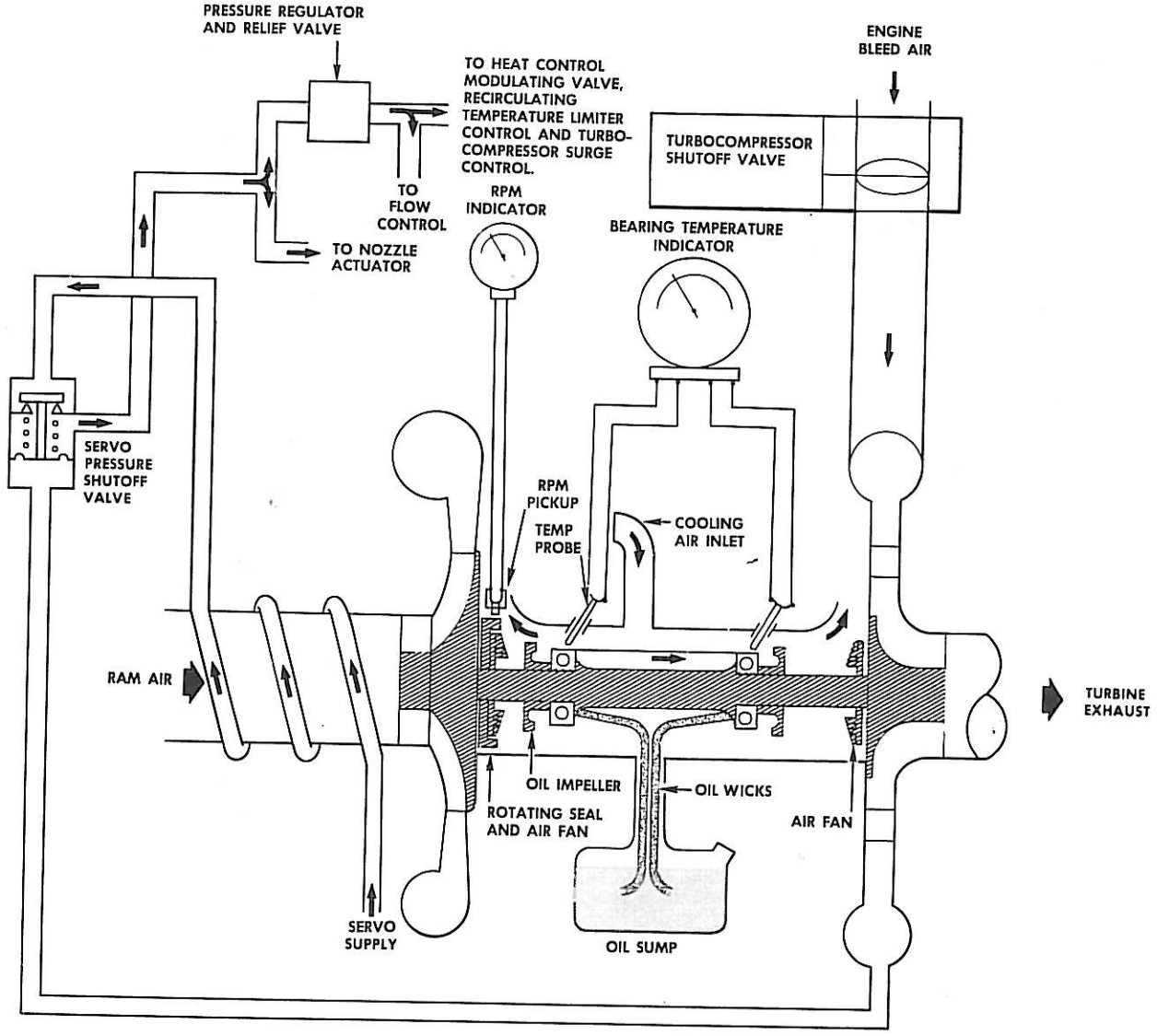
18. Turbocompressor RPM Indicator

A. Description.

Turbocompressor rpm indicators, shown on Figure 17, for the cabin and flight compartment pressurization systems are located on the flight engineer's control panel. They are used to detect improper operation of the turbocompressors, and are useful in troubleshooting the pressurization systems. The indicating system consists of the indicators and rotor speed pick-up coils.

B. Operation.

The rotor speed pick-up coil is mounted near the rotating seal on the impeller end of the rotor. Electrical pulses are induced in the electro-magnetic pick-up coil by six lugs on the rotating seal. The



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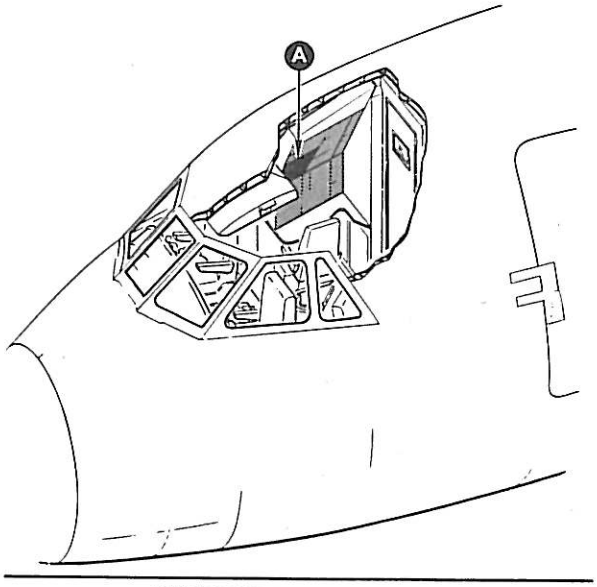
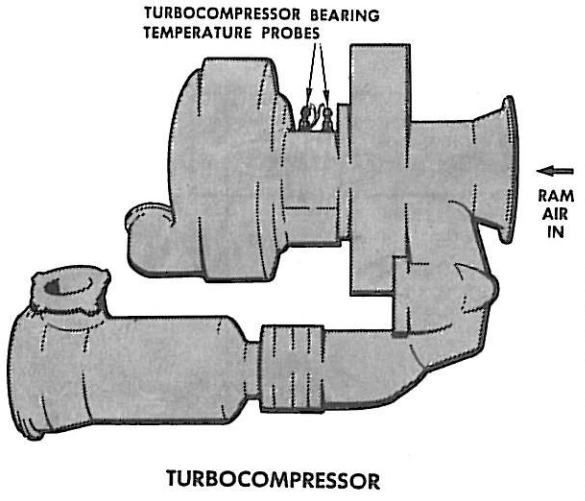
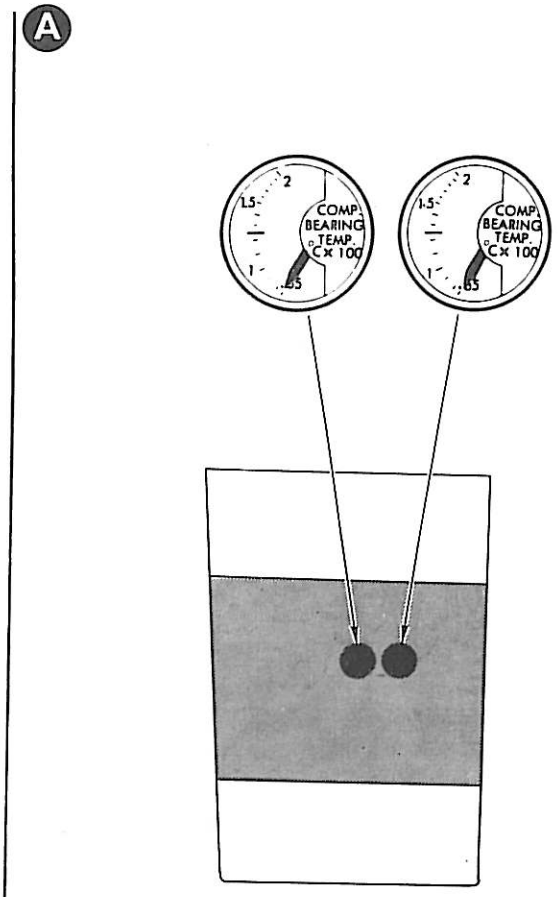
Turbocompressor Lubrication and Cooling Schematic
Figure 15

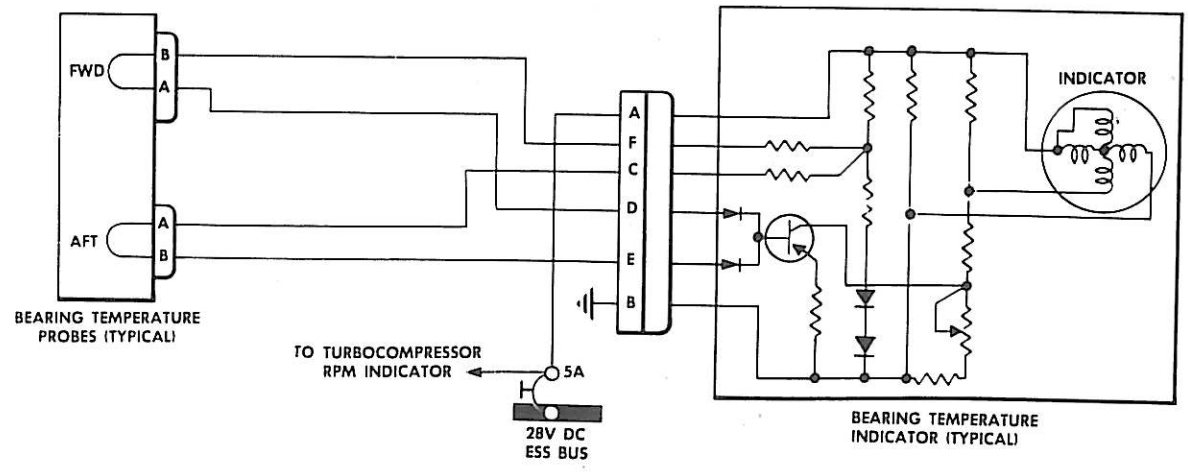




TURBOCOMPRESSOR



FLIGHT ENGINEER'S AIR CONDITIONING
AND PRESSURIZATION CONTROL PANEL



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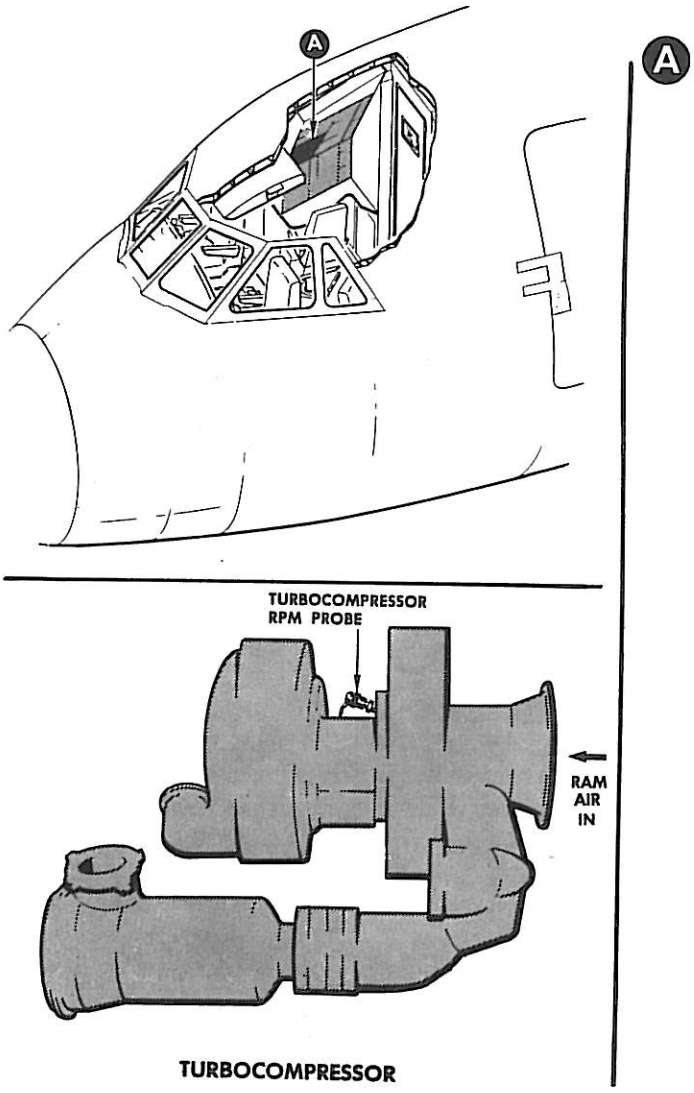
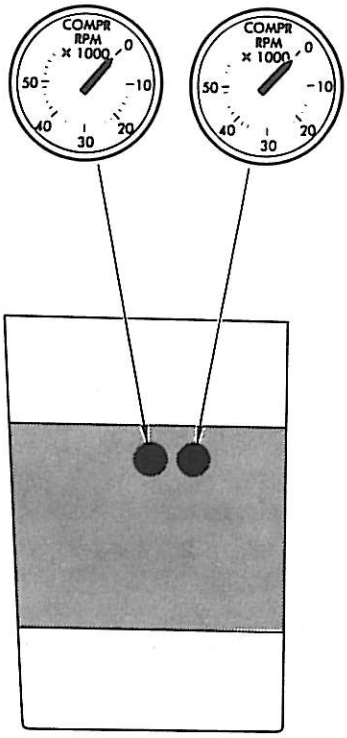
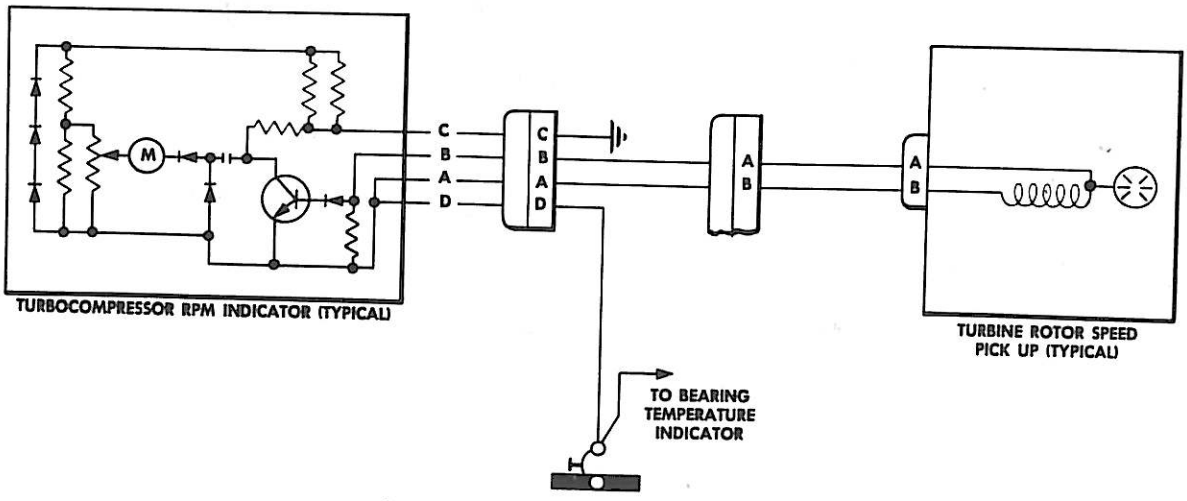
Turbocompressor Bearing Temperature Indicator
Figure 16



TURBOCOMPRESSOR



FLIGHT ENGINEER'S AIR CONDITIONING AND PRESSURIZATION CONTROL PANEL



TURBOCOMPRESSOR RPM INDICATOR (TYPICAL)

TURBINE ROTOR SPEED PICK UP (TYPICAL)

30.30.21.073 A

lugs cut the magnetic field of the electro-magnetic pickup to induce a pulse in the pickup coil. These pulses, whose rate varies directly with rotor rpm, are transmitted to a transistorized control circuit within the indicator. The control circuit converts the pulses into a steady dc current, which is proportional to the rate of the incoming pulses. The dc current operates a milliammeter which is calibrated to read revolutions per minute. The indicator dial has a range of zero to sixty thousand rpm. The maximum safe operating speed is indicated by a red mark on the dial at fifty thousand rpm.

19. Servo Pressure Shutoff Valve

A. Description.

The servo pressure shutoff valve, shown on Figure 18, consists of a turbine-pressure sensing chamber and a piston-operated ball valve. The shutoff valve is mounted on top of the compressor ram air inlet and is connected to the bleed air servo supply, pressure regulator and nozzle actuator servo pressure lines, and the compressor turbine exhaust scroll.

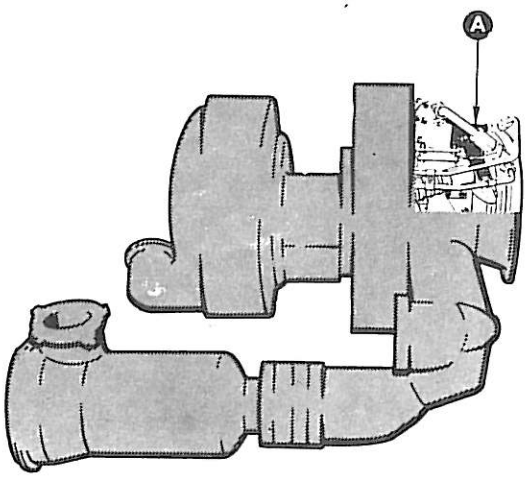
B. Operation.

The servo pressure shutoff valve prevents high pressure bleed air from striking the compressor turbine impeller blades when the variable area nozzle vanes are in the full open position. When the turbocompressor bleed air shutoff valve closes, turbine pressure in the servo pressure shutoff valve sensing chamber decreases and allows the piston-operated ball valve to seat. When the ball valve seats, servo supply pressure to the nozzle actuator is shut off thereby closing the nozzle vanes in the turbine.

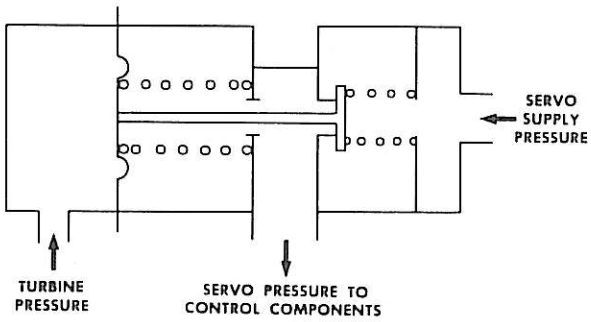
When the bleed air shutoff valve opens, turbine pressure increases in the servo pressure shutoff valve sensing chamber. When this pressure reaches a preset limit, the piston unseats the ball valve and allows servo pressure to enter the nozzle actuator which opens the nozzle vanes. This sequence of operation opens the nozzle vanes gradually to permit only a gradual acceleration of the turbine.

20. Servo Pressure Source

A. A 3/8-inch steel line is tapped from an elbow in the bleed air duct at each inboard pylon and is routed along the front side of the wing front spar. The line extends from the wing, through the fuselage and into the turbocompressor compartment where it connects to the turbocompressor. The line serves as a means of routing engine bleed air to the turbocompressor for control of the servo mechanisms.



TURBOCOMPRESSOR



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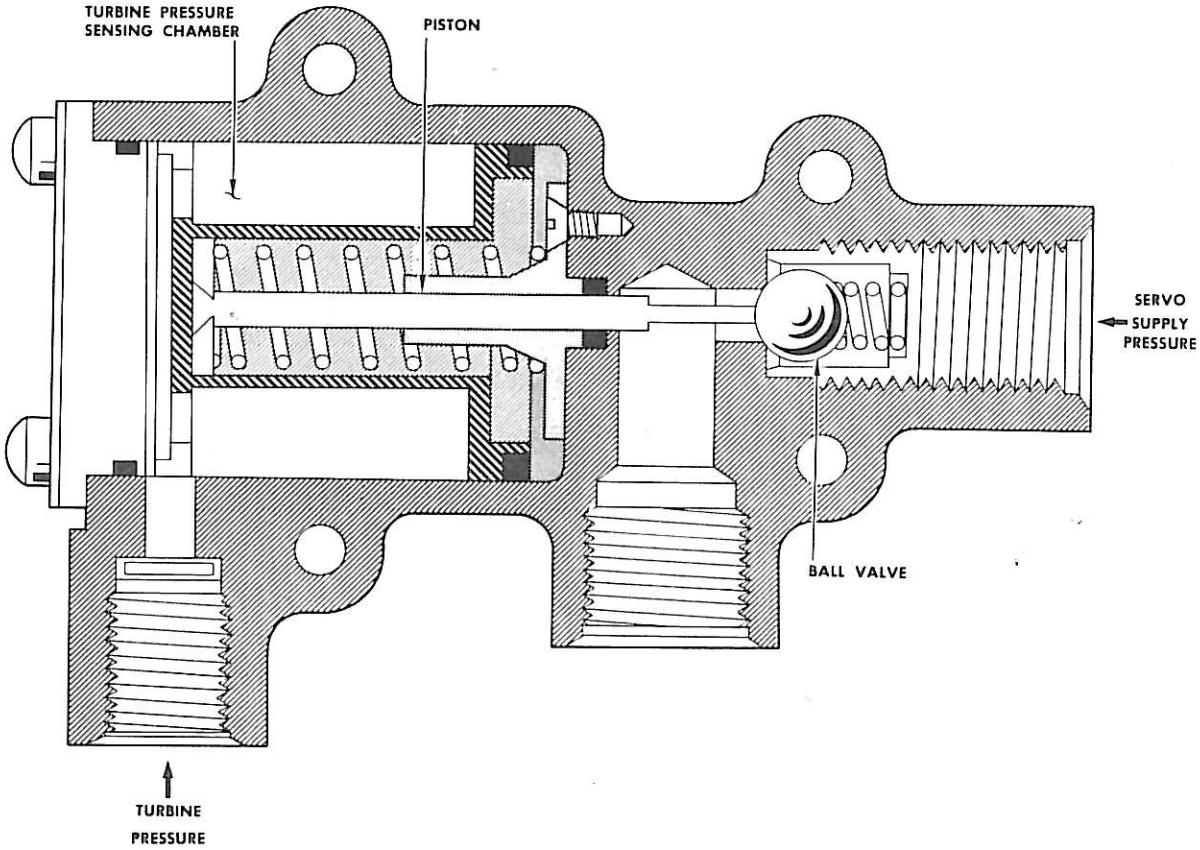


SERVO PRESSURE SHUTOFF VALVE

22.02.21.301

TURBOCOMPRESSOR ASSEMBLY - MAINTENANCE PRACTICES

1. Servicing

A. Turbocompressor.

(1) Open turbocompressor access doors on lower surface of fuselage.

(2) Check sight line level gage in turbocompressor oil sump. If oil level is above sight line, the sump contains a sufficient quantity of oil. If oil level is below sight line, oil shall be added (refer to Chapter 12, SERVICING).

2. Removal/Installation Turbocompressor

A. General.

(1) During line maintenance, the following components can be removed for replacement or repair while the turbocompressor package is installed in the airplane:

(a) Heat recirculation temperature limiter (refer to 21-1-4, Maintenance Practices).

(b) Turbocompressor surge valve (refer to 21-1-7, Maintenance Practices).

(c) Venturi duct (refer to 21-1-3, Maintenance Practices).

(2) The turbocompressor package must be removed from the airplane for quick replacement of the following components (refer to Maintenance practices of specific components).

(a) Bias altitude control (refer to 21-1-8, Maintenance Practices).

(b) Heat control modulating valve (refer to 21-1-11, Maintenance Practices).

(c) Recirculation altitude shutoff control (refer to 21-1-5, Maintenance Practices).

(d) Turbocompressor bearing temperature probes (refer to 21-1-9, Maintenance Practices).

(e) Turbocompressor RPM probe (refer to 21-1-10, Maintenance Practices).

(f) Pressure regulator and relief valve (refer to 21-1-6, Maintenance Practices).

(g) Servo pressure shutoff valve.

(3) The following components should be replaced only at an overhaul activity.

(a) Turbocompressor nozzle actuator.

(b) Turbocompressor flow control.

(c) Turbocompressor surge control.

(d) Overspeed cutout actuator.

(e) Turbocompressor overspeed control.

(f) Bias pressure control.

(g) Pressure limiter control.

B. Equipment Required.

A small table which can be raised or lowered to support the turbocompressor during removal and installation is recommended. The table must be small enough to allow access to the turbocompressor frame mounting bolts when it is in position under the turbocompressor. Without the table, at least two men are required to raise and lower the turbocompressor package. The turbocompressor package weighs approximately 90 pounds.

C. Preparation.

(1) Open the following circuit breakers.

(a) TURBO COMPR ON (cabin or flight deck).

(b) TURBO COMPRESSOR OFF (cabin or flight deck).

(c) TURBO COMPR INDICATOR (cabin or flight deck).

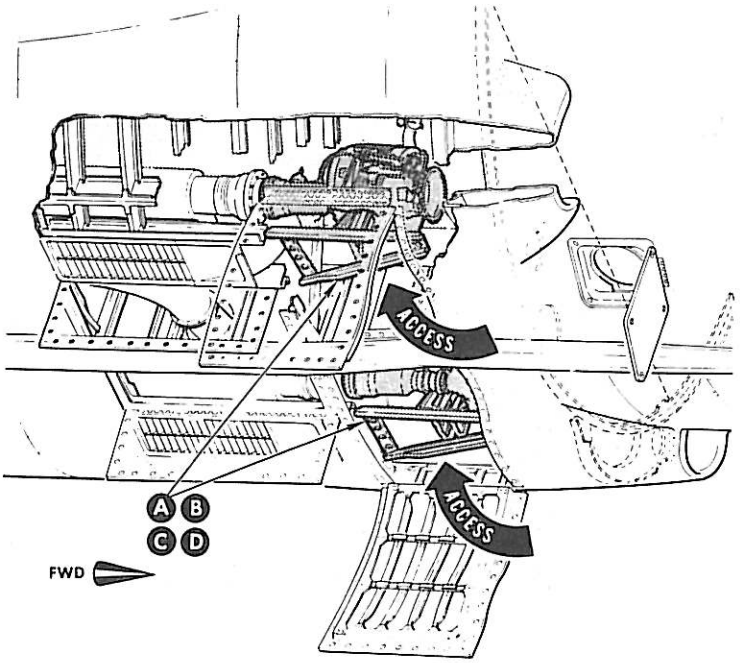
(d) CABIN FREON CONT.

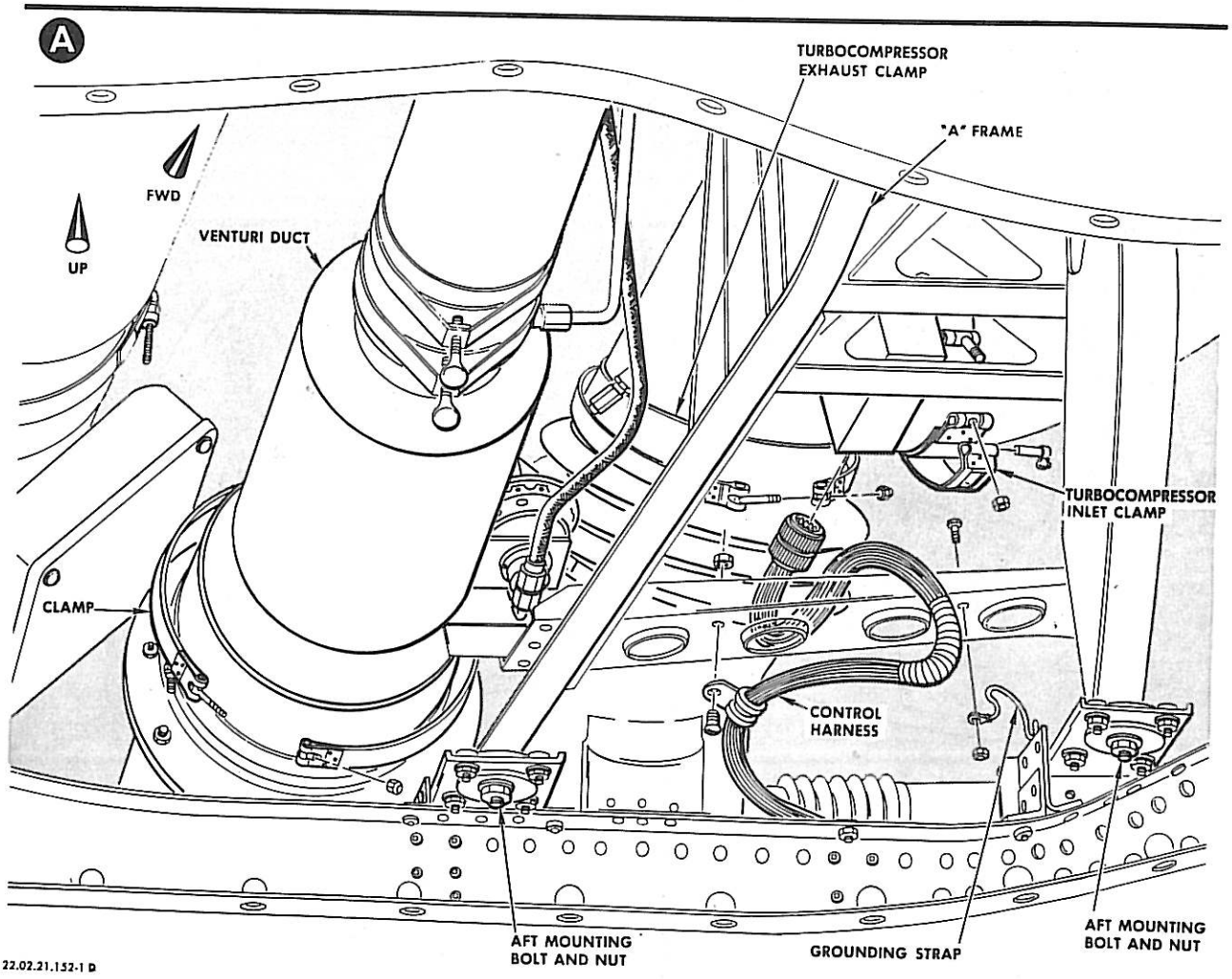
(2) Open turbocompressor access door (cabin or flight compartment).

NOTE: Step (3) is necessary only when removing the flight deck turbocompressor.

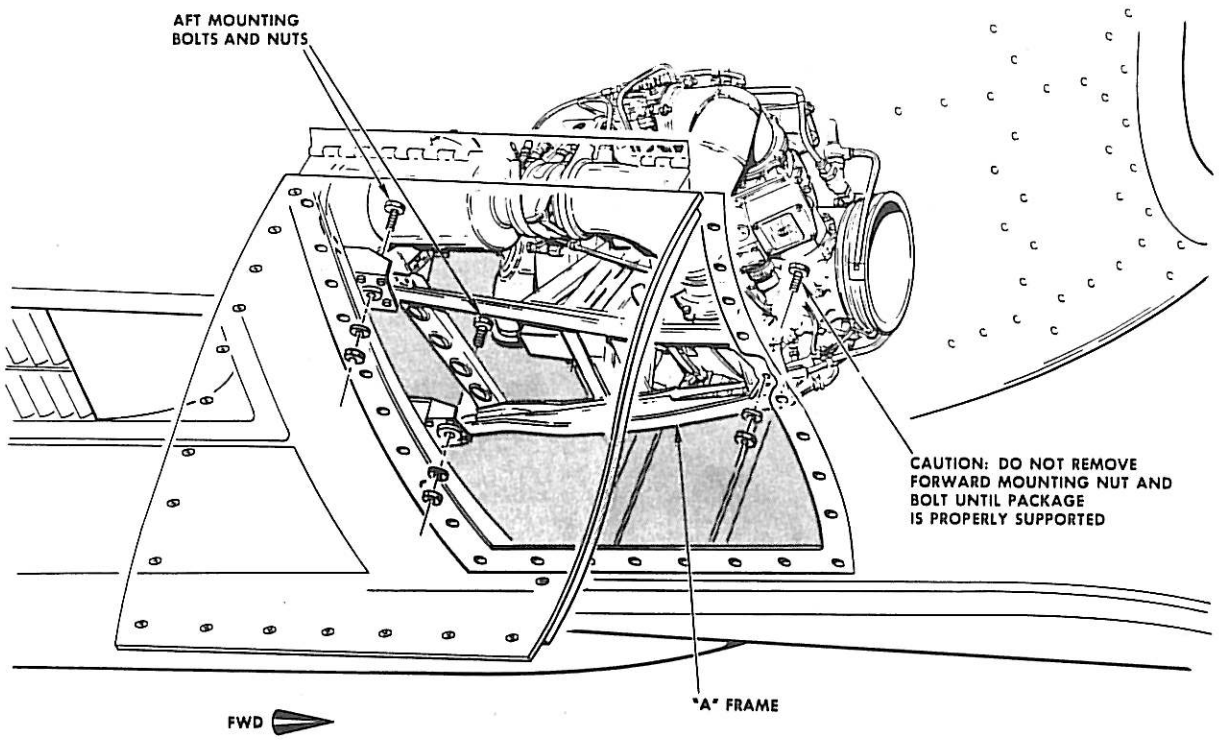
(3) Remove venturi duct and surge valve from turbocompressor as a unit (refer to 21-1-3, Maintenance Practices).

(4) Drain oil from turbocompressor sump (refer to Chapter 12, SERVICING).


ACCESS
ACCESS
A
B
C
D
FWD


A
TURBOCOMPRESSOR EXHAUST CLAMP
"A" FRAME
FWD
UP
VENTURI DUCT
TURBOCOMPRESSOR INLET CLAMP
CLAMP
CONTROL HARNESS
AFT MOUNTING BOLT AND NUT
GROUNDING STRAP
AFT MOUNTING BOLT AND NUT
22.02.21.152-1 D

B



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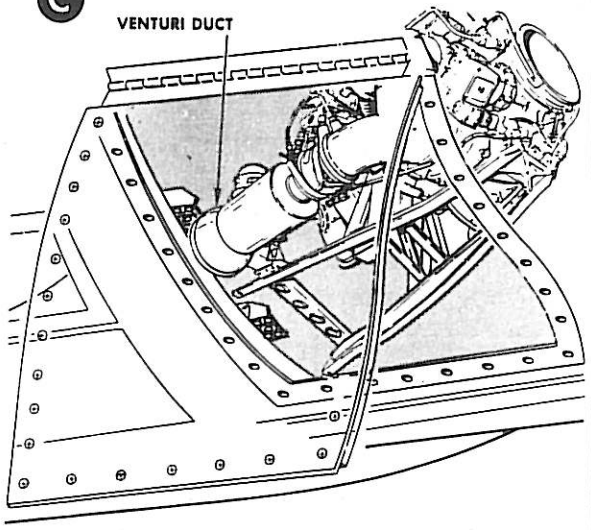
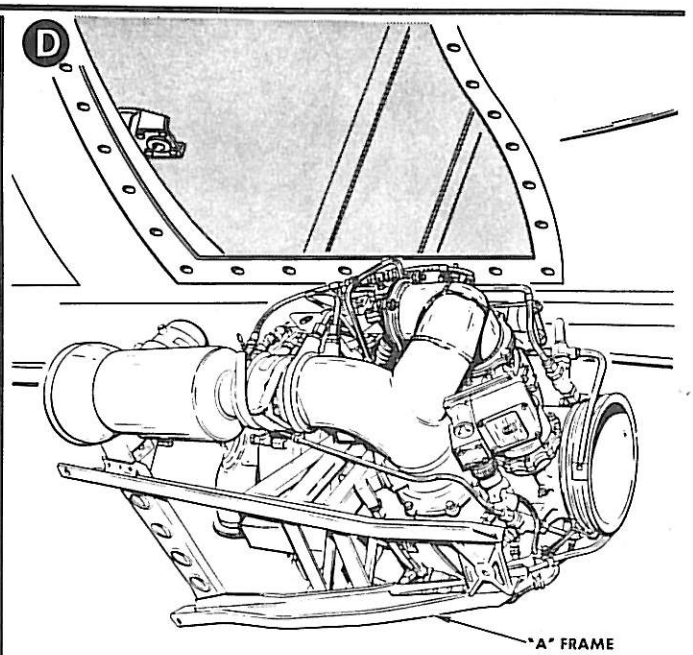


CAUTION: DO NOT HANDLE
PACKAGE BY LIFTING
ON VENTURI DUCT

D



NOTE: PRIMARY SUPPORT SHOULD
ALWAYS BE THROUGH
"A" FRAME. AVOID
HEAVY LOADS ON
PACKAGE COMPONENTS

22.02.21.152-2B

D. Remove Turbocompressor Package (see Figure 201).

Figure Detail

NOTE: Step (1) is necessary only when removing cabin (right) turbocompressor.

(1) Disconnect clamp at aft end of venturi duct. — A

(2) Disconnect package control harness at receptacle under turbine exhaust and remove clamp which secures harness to A frame. (Tag for installation.) (Cap receptacle and connector.) — A

(3) Disconnect turbine inlet clamp. — A

(4) Disconnect turbine exhaust duct clamps and remove duct. — A

(5) Disconnect bleed air shutoff valve vent line from overspeed control port 33, and servo supply tube at cooling coil connection. (Tag each line for installation.) (Cap ports and tubing.)

(6) Disconnect grounding strap from "A" frame (near left hand mounting point). — A

(7) Remove two nuts, washers, and bolts from aft mounting points of turbocompressor "A" frame. — B

CAUTION: DO NOT REMOVE FORWARD MOUNTING BOLT UNTIL PACKAGE IS PROPERLY SUPPORTED.

(8) Support turbocompressor "A" frame with a table, or by having two men support the package.

CAUTION: USE CARE TO HANDLE TURBOCOMPRESSOR PACKAGE BY "A" FRAME OR MAIN TURBO HOUSINGS ONLY. DO NOT USE VENTURI DUCT OR OTHER COMPONENTS AS HAND GRIPS.

(9) Remove forward "A" frame mounting bolt, then move turbocompressor aft and slightly upward.

(10) Shift turbocompressor and raise forward mounting point of "A" frame above forward support bracket.

(11) Move turbocompressor forward and slightly left and above forward support bracket.

(12) Lower aft end of turbocompressor through access door and remove turbocompressor from airplane.

NOTE: The "A" frame is not a part of the turbocompressor package, but is normally left attached to provide a convenient supporting base.

Figure
Detail

(13) When required, separate mounting frame from compressor by removing two screws and nuts that secure venturi duct to frame (if not previously removed), then remove four mounting bolts which secure package to frame.

E. Install Turbocompressor Package.

CAUTION: USE CARE TO HANDLE TURBOCOMPRESSOR PACKAGE BY "A" FRAME OR MAIN TURBO HOUSINGS ONLY. DO NOT USE VENTURI DUCT OR OTHER COMPONENTS AS HAND GRIPS.

(1) When required, attach turbocompressor to "A" frame with four mounting bolts. Attach venturi duct bracket to "A" frame with two screws and nuts.

(2) Raise forward end of turbocompressor into forward area of turbocompressor compartment above and slightly left of forward support bracket.

(3) Raise aft end of turbocompressor until aft mounting points of "A" frame are above aft support brackets in airplane. Move turbocompressor aft until forward mounting point of "A" frame can be lowered below forward support bracket. Secure forward mounting point with bolt, washer and nut.

NOTE: Slight shifting may be necessary for alignment of all three mounting points.

(4) Install two bolts, washers, and nuts to secure the two aft connections of the "A" frame. B

(5) Attach electrical grounding strap near left-hand mounting point of "A" frame. A

(6) Connect bleed air shutoff valve vent line to overspeed control port, and connect servo supply line to cooling coil inlet. Tighten coupling nuts 1/6 to 1/3 turn beyond point of initial torque rise.

(7) Position and connect bleed air inlet duct to turbine inlet; secure with clamp. A

(8) Install and connect turbine exhaust duct to discharge duct in airplane; secure with clamp. A

(9) If installing flight deck turbocompressor, install venturi duct and surge valve (refer to Removal/Installation Venturi Duct).

(10) If installing cabin turbocompressor, position hose to connect aft end of venturi duct to air conditioning system duct; secure with clamp.

(11) Connect control harness to electrical receptacle under turbine scroll, and install clamp to secure harness to A frame.

(12) Add oil to turbocompressor sump (refer to Chapter 12, SERVICING).

(13) Close TURBO COMPR ON, TURBOCOMPRESSOR OFF, and TURBO COMPR INDICATOR circuit breakers.

(14) Perform operational check of turbocompressor (refer to 21-0, Maintenance Practices).

(15) Recheck duct clamps for security.

(16) With turbocompressor operating check three flexible servo lines, servo inlet fitting, and overspeed cutout fitting for leaks.

(17) Close turbocompressor access door.

3. Adjustment/Test

A. Turbocompressor Package - Leakage Test.

(1) Apply 12 psig pressure to servo inlet.

(2) Apply Leak-Tec or equivalent to all servo tube connections and detect leaks by observing bubble formation.

NOTE: Leak-Tec is manufactured by American Gas and Chemicals Inc., New York, N.Y.

(3) When leakage occurs at couplings, back off coupling nut(s) and examine nut, sleeve and tubing for burrs, metal chips, nicks or cracks. Remove burrs or chips when present and tighten coupling nut 1/6 to 1/3 turn beyond point of initial torque rise.. Nicked or cracked parts necessitate replacement of the entire tubing assembly.

NOTE: Leakage from control poppets is permissible. Open servo ports may be capped when required to build up servo line pressure.

4. Inspection/Check

A. Maintenance Check.

(1) Examine package mounting bracket on venturi duct for bends or cracks.

(2) Check four frame mounting bolts for tightness.

(3) Examine all clamps for tightness and signs of cracks or corrosion.

(4) Check all servo tubing for sharp bends or cracks that might impair servo pressure supply.

(5) Examine electrical harness for damaged insulation on wires. Check receptacle connections for tightness.

(6) Examine bleed air and ram air ducts for dents, scratches, cracks or internal obstruction.

(7) Manually rotate turbocompressor rotor, checking for obvious noise or resistance to rotation.

5. Cleaning/Painting

A. Clean Turbocompressor Assembly.

(1) Clean exterior surfaces with solvent, Specification AMS 3160A, to remove any dirt or oil deposits.

WARNING: EXERCISE CARE TO INSURE THAT NO SOLVENT ENTERS THE DIAPHRAGM CHAMBER OF CONTROLS OR CABIN AIR PORTS OF THE PACKAGE. APPLY SOLVENT WITH A SOFT LINTLESS CLOTH MOISTENED WITH SOLVENT USING A MINIMUM AMOUNT OF CLEANER ON ELECTRICAL PARTS.

(2) Remove corrosion with steel wool or crocus cloth.

B. Paint Turbocompressor Assembly.

(1) Touch up worn or damaged painted surfaces when extent of damage does not exceed approximately 5 percent of the total painted surface.

(2) Mask all areas that do not require painting (ports, plated areas or identification) but are near the damaged areas.

(3) Use Sicon 7X938 black enamel or equivalent on all parts subject to high temperatures - the bleed air shutoff valve body and turbine housing. Thin the paint with toluol, Specification AMS 3180B, using seven parts paint to one part toluol.

NOTE: Sicon is obtainable from Midland Industrial Finishes, Waukegan, Illinois.

(4) Use one coat of glyceryl phthalate black enamel, Specification AMS 3120B, without primer for the compressor housings, overspeed control housing, cabin heat control valve body, surge valve body, venturi duct, temperature limiter control or transition outlet duct.

(5) Use one coat of zinc chromate primer, Specification AMS 3110C, and two coats of black enamel, Specification AMS 3120B, on all other painted parts.

(a) Apply primer smoothly to obtain an even semi-transparent greenish yellow surface.

(b) Before painting, allow primer to air dry 30 minutes minimum at room temperature.

(6) Allow each topcoat application to air dry at room temperature for four hours.

TURBOCOMPRESSOR SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Shutoff Valve (see Figure 201)

A. Remove Turbocompressor Shutoff Valve.

(1) Remove turbocompressor package (refer to 21-1-1, Maintenance Practices).

(2) Disconnect electrical connector from solenoid receptacle.

(3) Disconnect overspeed vent line from valve port 30. (Tag for installation.) (Cap tube ends.)

(4) Remove lock pins from duct clamps at each end of valve and remove duct clamps. Remove gaskets from each end of valve and remove valve.

B. Install Turbocompressor Shutoff Valve.

(1) Position shutoff valve between open ends of bleed air duct.

CAUTION: BE SURE THE CAST ARROW ON THE VALVE POINTS DOWNSTREAM TOWARD THE TURBINE INLET OF THE TURBOCOMPRESSOR.

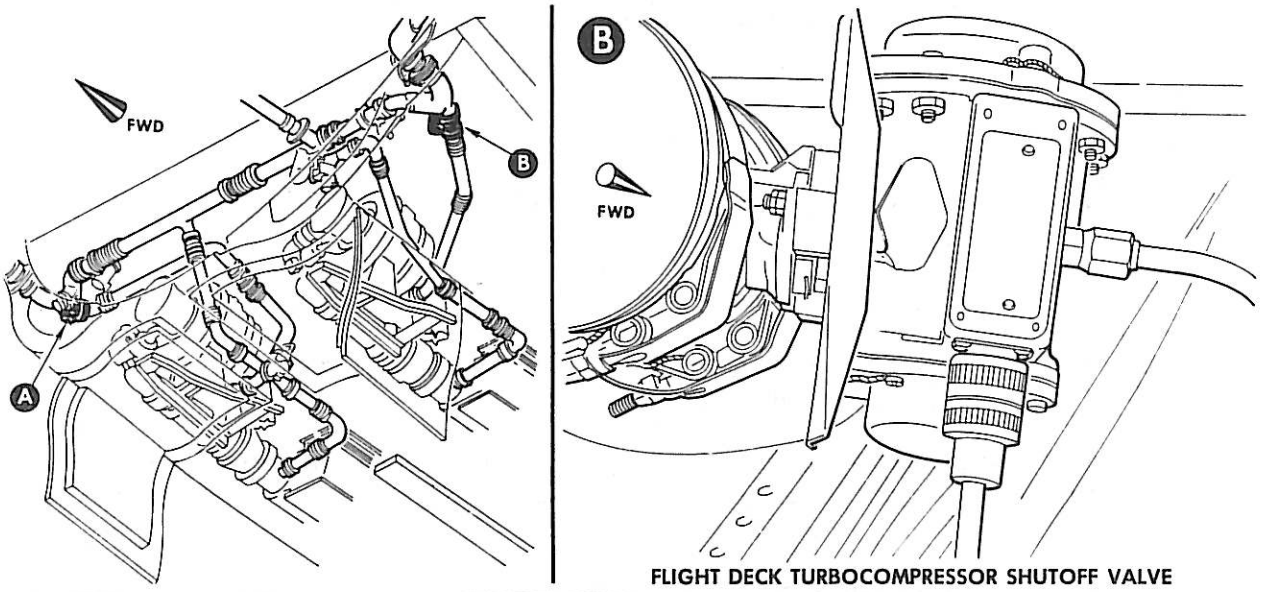
(2) Insert gaskets between valve and duct at each end of valve and secure valve with clamps (refer to Chapter 36, PNEUMATICS).

(3) Connect overspeed vent line to valve actuator port 30.

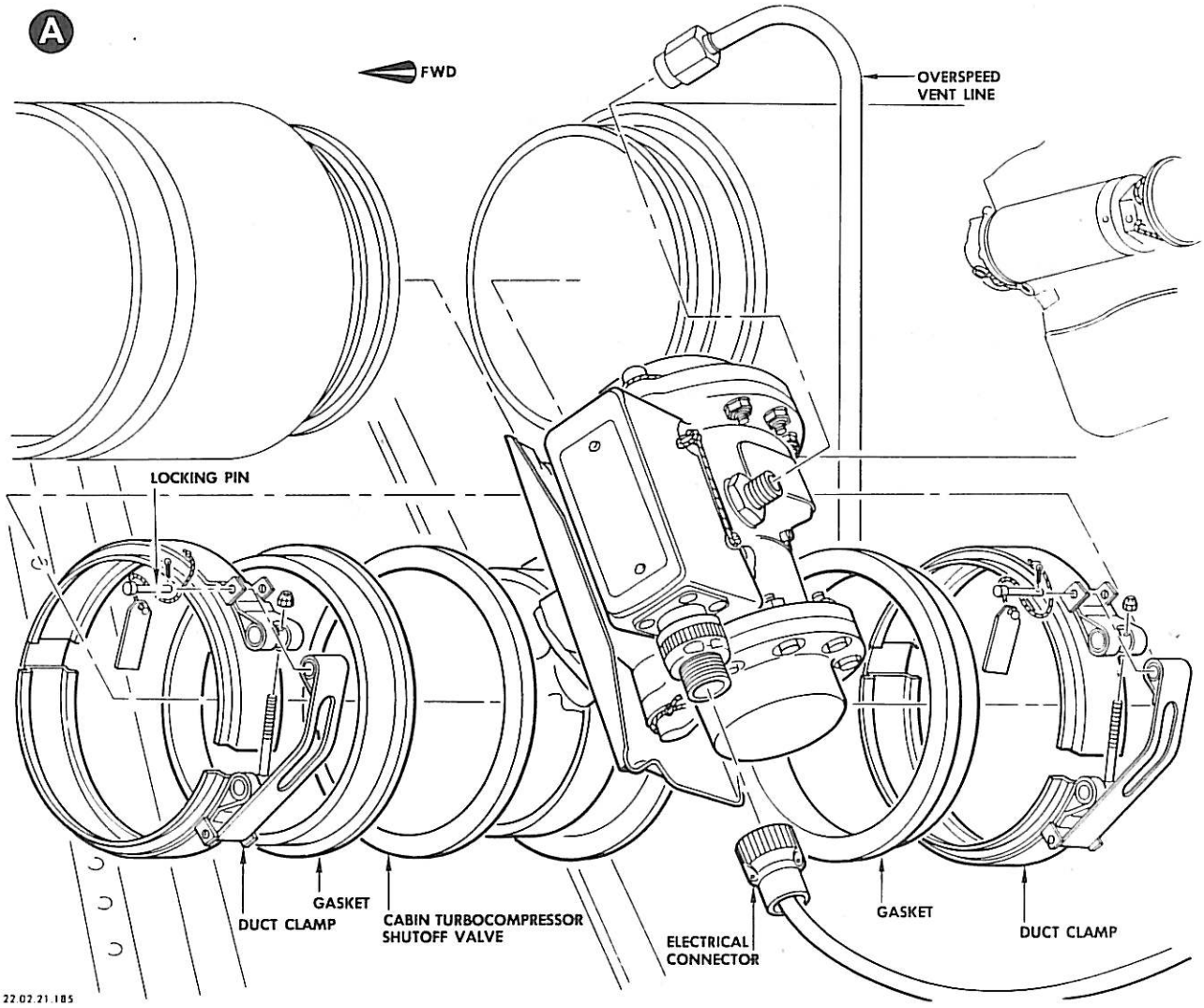
(4) Connect electrical connector to solenoid receptacle.

(5) Install turbocompressor package (refer to 21-1-1, Maintenance Practices).

(6) Check valve operation by operating the turbocompressor.



FLIGHT DECK TURBOCOMPRESSOR SHUTOFF VALVE



VENTURI DUCT - MAINTENANCE PRACTICES

1. Removal/Installation Venturi Duct (see Figure 201)

   A. Remove Venturi Duct.

      CAUTION: REMOVAL OF THE VENTURI DUCT FROM THE TURBOCOMPRESSOR IS PROHIBITED DURING LINE MAINTENANCE UNLESS THE SAME VENTURI DUCT IS INSTALLED ON THE TURBOCOMPRESSOR FROM WHICH IT WAS REMOVED. THE VENTURI DUCT AND TURBOCOMPRESSOR ARE MATED PARTS AND ARE NOT INTERCHANGEABLE WITH OTHER UNITS. IN CASE OF A DAMAGED VENTURI DUCT, THE ENTIRE TURBOCOMPRESSOR PACKAGE MUST BE REPLACED.

      (1) Disconnect and remove duct clamps from each end of venturi duct.

      (2) Disconnect three flexible servo lines from venturi duct; tag lines for installation. (Cap open lines and fittings.)

      (3) Loosen and remove bolts securing venturi duct to turbocompressor "A" frame; remove venturi duct with surge valve attached.

   B. Install Venturi Duct.

      (1) Install venturi duct (surge valve attached) by placing small diameter end into turbocompressor outlet duct; install and secure duct clamp.

      (2) Connect outlet end of venturi to turbocompressor check valve duct and install and secure duct clamp.

      (3) Install bolts through venturi duct mounting bracket and turbocompressor "A" frame; tighten bolts.

      (4) Connect three flexible servo lines to venturi duct; tighten coupling nuts.

2. Adjustment/Test

   A. Equipment Required.

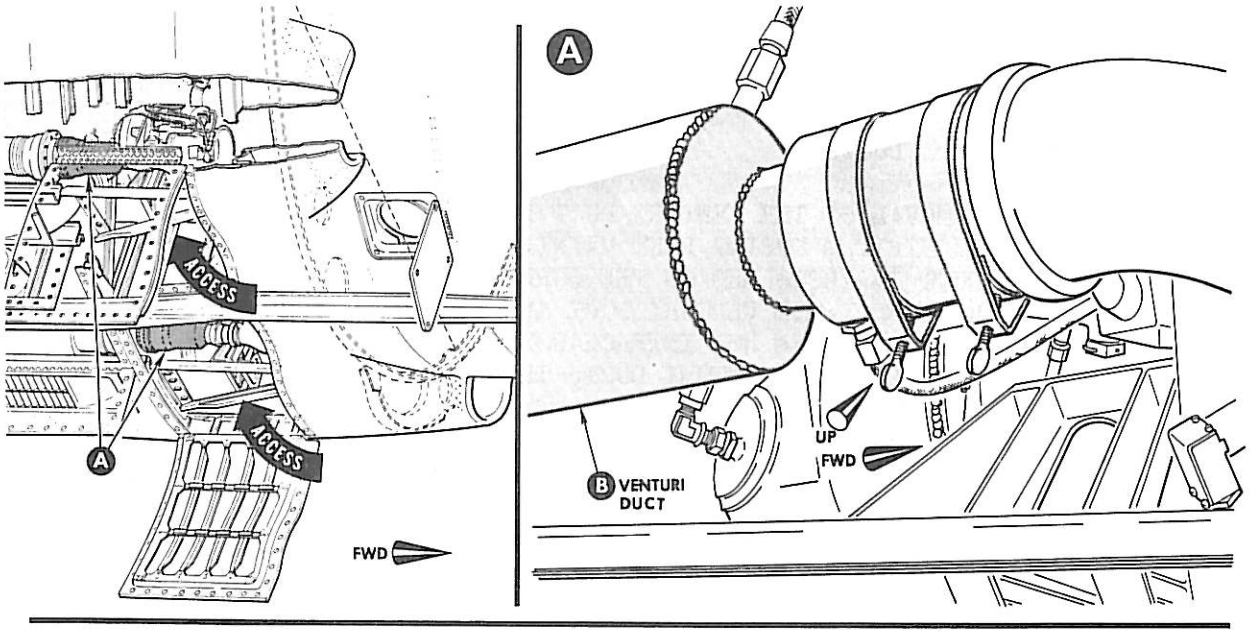
      (1) Pressure caps capable of withstanding 40 psi.

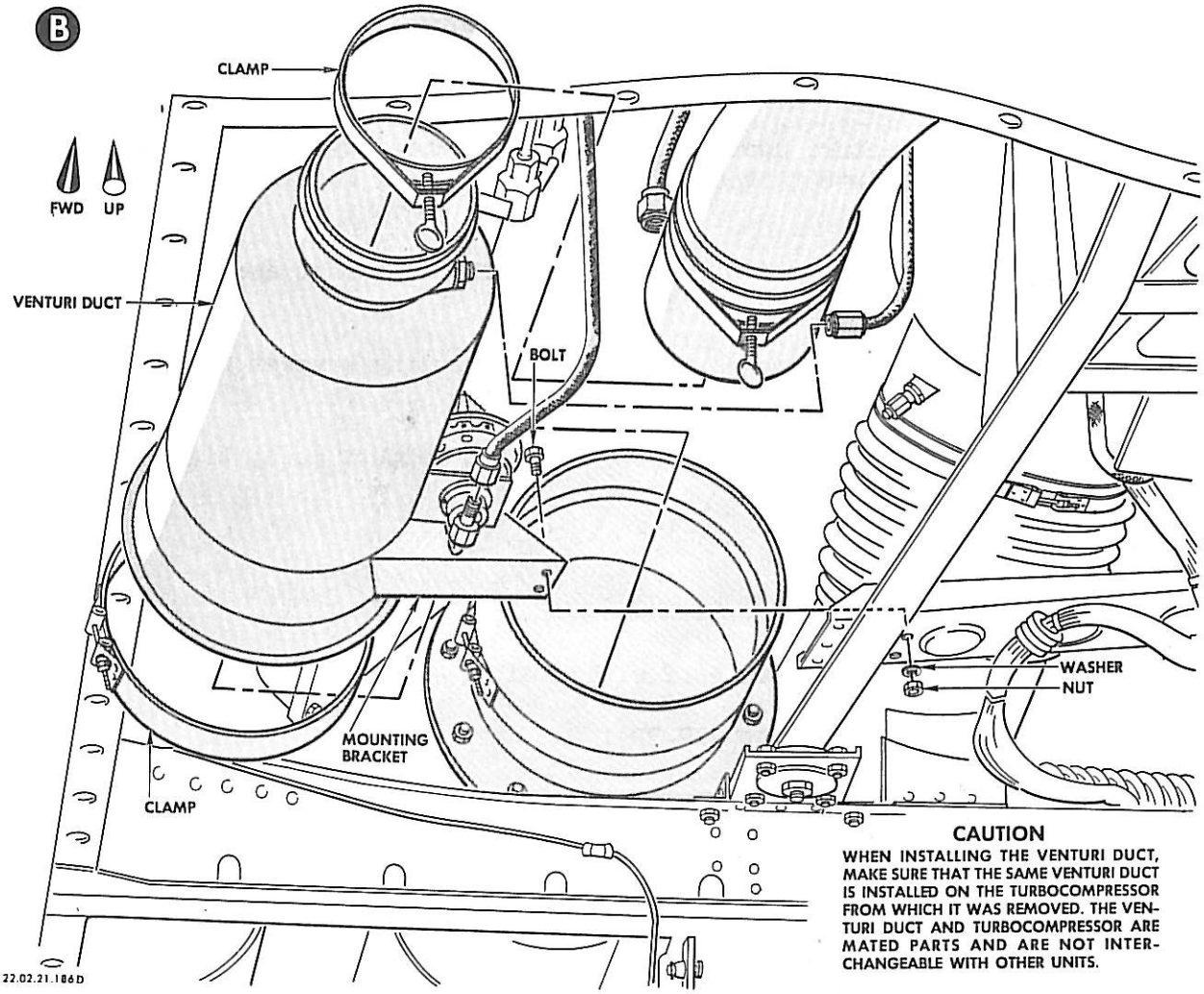
      (2) Reducer fitting (AN 919-3D).

      (3) Air pressure source.

   B. Venturi Leak Test.

      (1) Plug tapped venturi boss and cap venturi inlet and surge valve port (surge valve removed).





CAUTION

WHEN INSTALLING THE VENTURI DUCT, MAKE SURE THAT THE SAME VENTURI DUCT IS INSTALLED ON THE TURBOCOMPRESSOR FROM WHICH IT WAS REMOVED. THE VENTURI DUCT AND TURBOCOMPRESSOR ARE MATED PARTS AND ARE NOT INTERCHANGEABLE WITH OTHER UNITS.

(2) Cap venturi outlet with cap containing air pressure fitting.

(3) Pressurize venturi to 18 psig maximum through air fitting on outlet cap, then shut off air pressure. Venturi shall maintain pressure with no detectable pressure loss during five minute test period.

C. Venturi Air Chamber Leak Test.

(1) Cap air chamber port on top of venturi with reducer fitting (AN 919-3D).

(2) Pressurize air chamber to 30 psig maximum through reducer fitting, then shut off air pressure. Air chamber shall maintain pressure with no detectable pressure loss during five minute test period.

3. Inspection/Check

A. Examine external condition of venturi tube.

(1) Check tapped boss for worn or damaged threads.

(2) Examine painted surfaces for wear or damage.

(3) Check all exposed metal for corrosion.

(4) Note any dents in the duct that may affect air flow or flow sensing.

(5) Examine the ribbed connecting ends for damage that might cause leakage.

(6) Check the turbocompressor package mounting bracket for bending or other damage.

(7) Check the duct bore for burrs, cracks, or dents that might affect air flow.

(8) Examine the four 0.055 inch holes in the venturi pickup for dirt.

4. Cleaning/Painting

A. Clean the venturi duct by immersion, swabbing, or brushing with AMS 3160A solvent to remove oil and grease deposits.

WARNING: DO NOT ALLOW SOLVENT TO ENTER AIR CHAMBER; DRY THE BORE THOROUGHLY WITH A DRY LINTLESS CLOTH.

B. Touch up damaged surface when the extent of damage does not exceed one square inch or five percent of the total painted area, using one coat of AMS 3120B and allow to dry thoroughly for at least four hours.

HEAT RECIRCULATION TEMPERATURE LIMITER CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Heat Recirculation Temperature Limiter Control (see Figure 201)

   A. Remove Heat Recirculation Temperature Limiter Control.

      (1) Loosen fitting and disconnect servo bleed air tube.

      (2) Remove safety wire and remove retaining screws from mounting flange.

      (3) Remove temperature limiter control and gasket.

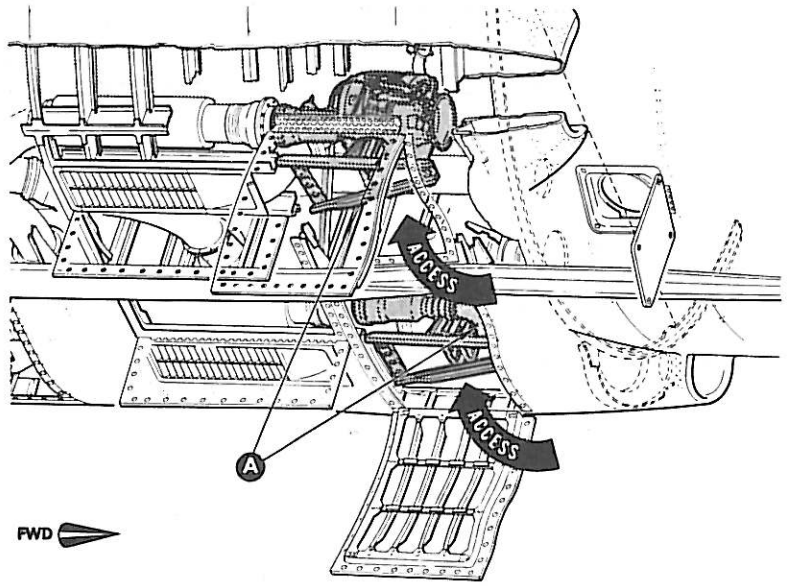
      CAUTION: INSTALL PROTECTIVE SHIELD AROUND PROBE TO PREVENT DAMAGE.

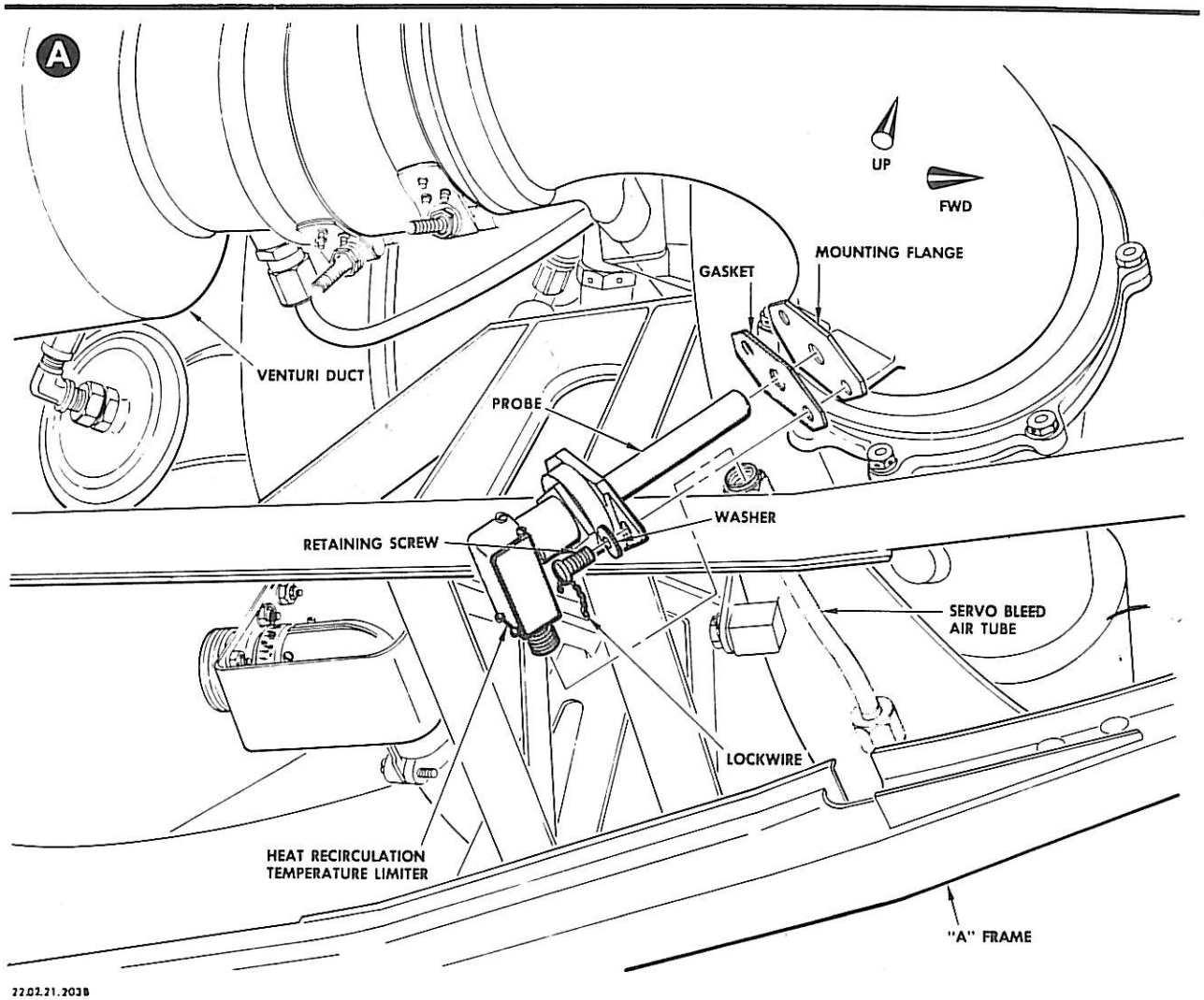
   B. Install Heat Recirculation Temperature Limiter Control

      (1) Place temperature limiter control and gasket, probe end first, into compressor discharge duct.

      (2) Align mounting flange holes with holes in duct and install screws; secure screws with lockwire.

      (3) Connect servo bleed air tube.





Heat Recirculation Temperature Limiter Control Installation
Figure 201

RECIRCULATION ALTITUDE SHUTOFF CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Recirculation Altitude Shutoff Control (see Figure 201)

A. Remove Recirculation Altitude Shutoff Control.

(1) Remove turbocompressor package (refer to 21-1-1, Maintenance Practices).

(2) Loosen coupling nut and disconnect servo tube from shutoff control.

(3) Remove four retaining nuts securing shutoff control to mounting bracket attached to compressor shield; lower shutoff control from mounting bracket and remove washers, shockmounts, sleeves and packings from bracket.

(4) Loosen lock nut and remove elbow fitting from control; hold elbow for installation on replacement control.

B. Install Recirculation Altitude Shutoff Control.

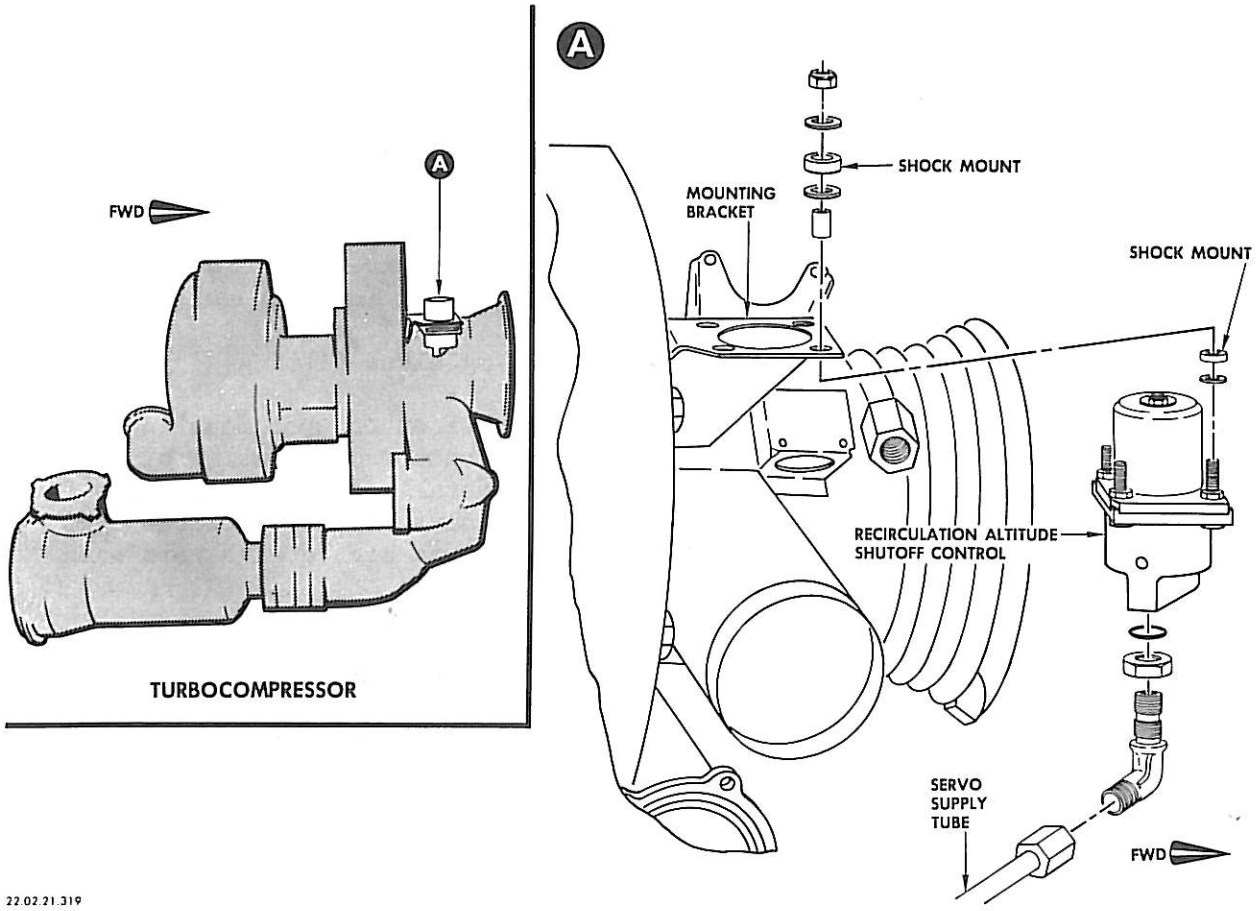
(1) Install elbow fitting in control port (port 88) pointing elbow toward the 11 o'clock position when viewing port 88 with port 87 at six o'clock position; secure elbow fitting lock nut.

NOTE: Use new O-ring when installing elbow fitting.

(2) Place washers, sleeves and shockmounts on control mounting studs and install shutoff control through bottom of mounting bracket (attached to compressor shield). Install control with elbow fitting pointing away from compressor inlet. Place packings over sleeves, add shockmounts and washers and secure with retaining nuts.

(3) Connect servo tube to shutoff control and tighten coupling nut 1/6 to 1/3 turn beyond point of initial torque rise.

(4) Install turbocompressor package (refer to 21-1-1, Maintenance Practices).



Recirculation Altitude Shutoff
Control Installation
Figure 201

PRESSURE REGULATOR AND RELIEF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Pressure Regulator and Relief Valve (see Figure 201)

   A. Remove Pressure Regulator and Relief Valve.

      (1) Remove turbocompressor package (refer to 21-1-1, Maintenance Practices).

      (2) Disconnect servo tube coupling nuts.

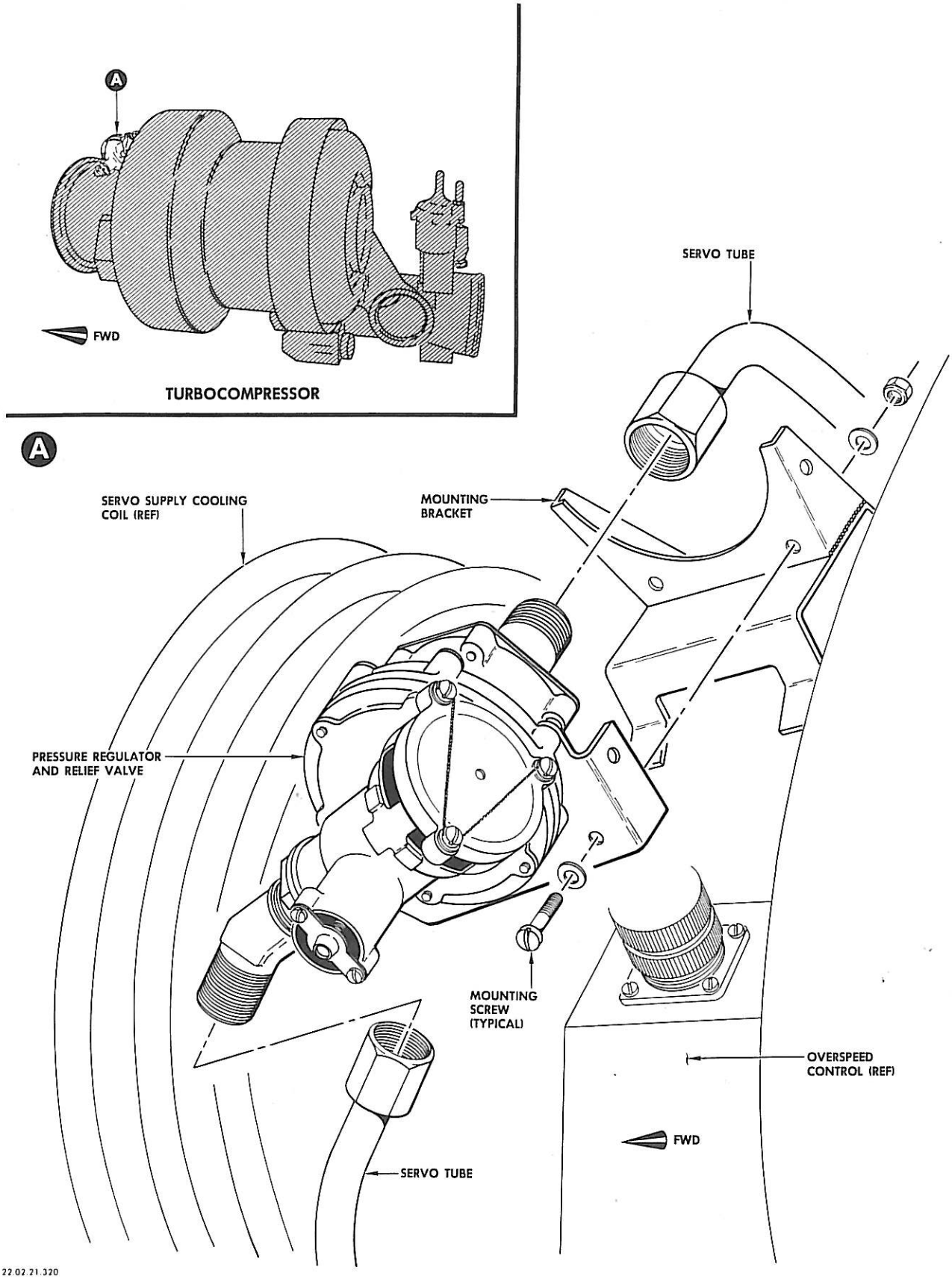
      (3) Remove retaining screws and nuts securing valve bracket to bracket on compressor inlet above overspeed control.

   B. Install Pressure Regulator and Relief Valve.

      (1) Install valve bracket to mounting bracket on compressor inlet above overspeed control; secure with screws and nuts.

      (2) Connect servo tubes to valve; tighten coupling nuts 1/6 to 1/3 turn beyond point of initial torque rise.

      (3) Install turbocompressor package (refer to 21-1-1, Maintenance Practices).



Pressure Regulator and Relief Valve Installation
Figure 201

TURBOCOMPRESSOR SURGE VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Surge Valve (see Figure 201)

   A. Remove Turbocompressor Surge Valve.

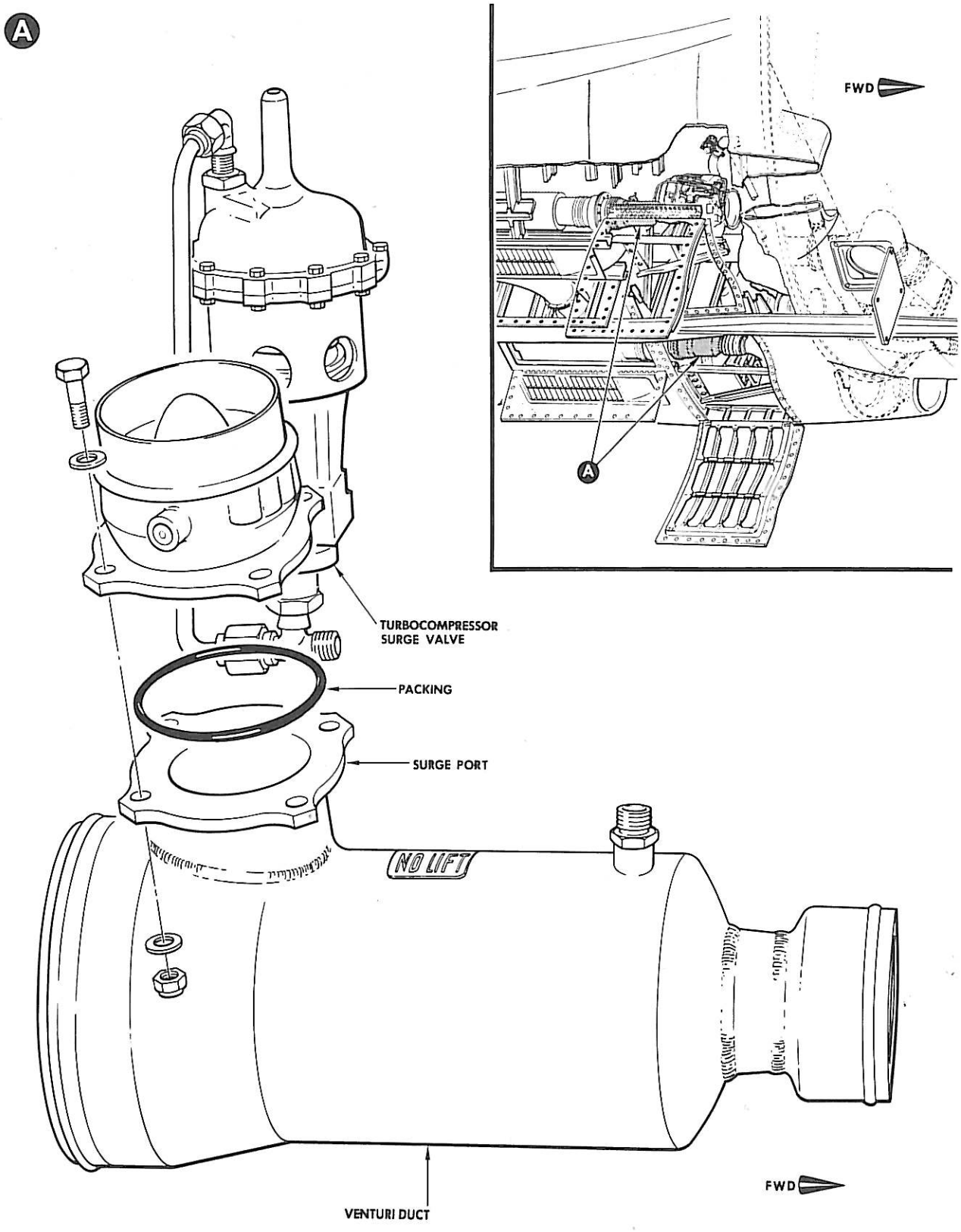
      (1) Remove venturi duct with surge valve attached (refer to 21-1-3, Maintenance Practices).

      (2) Remove flange nuts and bolts securing valve to venturi duct; remove valve and packing.

   B. Install Turbocompressor Surge Valve.

      (1) Attach surge valve with packing to mounting flange on venturi duct and secure with bolts and nuts.

      (2) Install venturi duct and surge valve on turbocompressor (refer to 21-1-3, Maintenance Practices).



Turbocompressor Surge Valve Installation
Figure 201

BIAS ALTITUDE CONTROL - MAINTENANCE PRACTICES

1. Removal/Installation Bias Altitude Control (see Figure 201)

A. Remove Bias Altitude Control.

(1) Remove turbocompressor package (refer to 21-1-1, Maintenance Practices).

(2) Loosen coupling nuts and disconnect tubing connected to tee fitting on bottom of bias control and port 15 of surge control.

(3) Loosen coupling nuts and disconnect tubing connected to port 84 of bias control and tee fitting in port 20 of surge control; disconnect tubing from clamp attached to electrical harness.

(4) Remove four retaining nuts securing bias control to mounting bracket attached to compressor turbine shield; lower bias control from mounting bracket and remove washers, shockmounts, packings and sleeves from control and bracket.

(5) Loosen lock nut and remove tee fitting (with orifice plug) from control; hold tee for installation on replacement control.

(6) Remove union and O-ring from bottom of control; hold union for installation on replacement control.

B. Install Bias Altitude Control.

(1) Install tee fitting (with orifice plug) in port 85 and union in port 84 of bias control; use new packing when installing tee and union. Do not tighten tee or lock nut at this time.

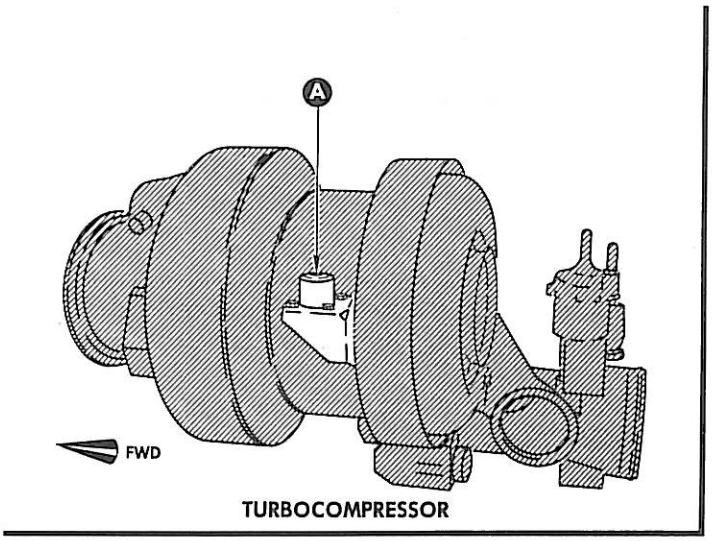
(2) Place washers, sleeves and shockmounts on control mounting studs and install control through bottom of mounting bracket (attached to compressor turbine shield). Place packings over sleeves, add shockmounts and washers and secure control with four retaining nuts.

(3) Position tee fitting (installed in step (1)) pointing away from turbocompressor and secure with locknut.

(4) Connect tubing between tee fitting on bias control and port 15 of surge control (above bias control); connect tubing between port 84 of bias control and tee fitting in port 20 of surge control. Tighten coupling nuts at ends of both tubes 1/6 to 1/3 turn beyond point of initial torque rise.

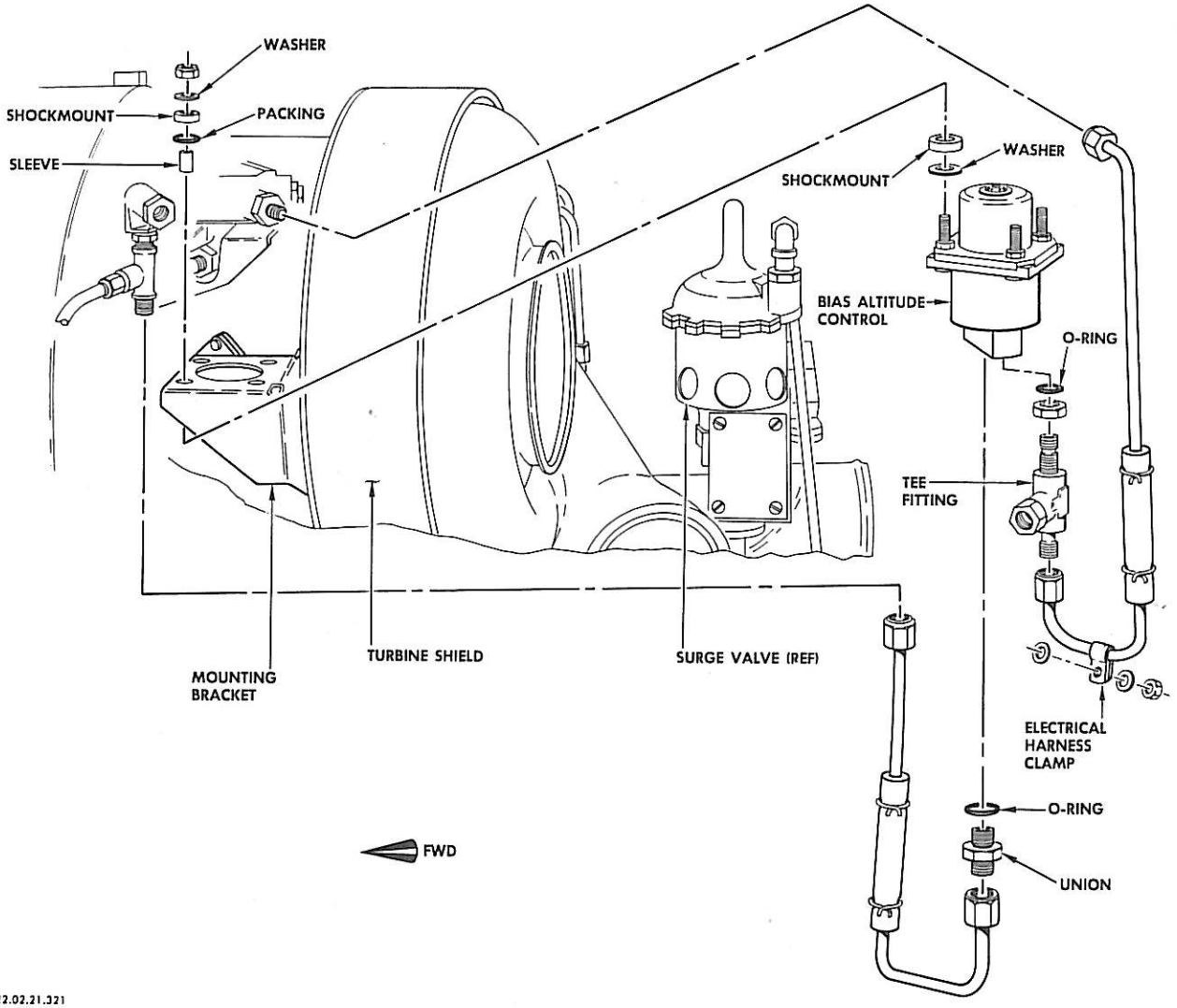
(5) Attach tube (connected to port 84 of bias control and tee fitting in port 20 of surge control) to electrical harness with clamp and secure with screw and lock nut.

(6) Install turbocompressor package (refer to 21-1-1, Maintenance Practices).



TURBOCOMPRESSOR

A



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Bias Altitude Control Installation
Figure 201

TURBOCOMPRESSOR BEARING TEMPERATURE INDICATOR AND BEARING TEMPERATURE PROBE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor Bearing Temperature Indicator

NOTE: For removal of turbocompressor bearing temperature indicator, refer to Chapter 31, INSTRUMENTS.

A. Remove Bearing Temperature Probe from Turbocompressor (see Figure 201).

(1) Remove turbocompressor package (cabin or flight compartment) from airplane (refer to 21-1-1, Maintenance Practices).

(2) Disconnect electrical connector from temperature probe. Forward and aft temperature probes are located along the top centerline of bearing housing between the turbine and impeller.

(3) Remove safety wire from probe.

(4) Remove probe by turning counterclockwise.

(5) Cover opening to prevent entry of dust and dirt into compressor housing.

B. Install Bearing Temperature Probe on Turbocompressor (see Figure 201).

(1) Install and tighten temperature probe in opening provided on top of bearing housing.

(2) Install safety wire on temperature probe.

(3) Connect electrical connector to probe.

(4) Install turbocompressor package in airplane (refer to 21-1-1, Maintenance Practices).

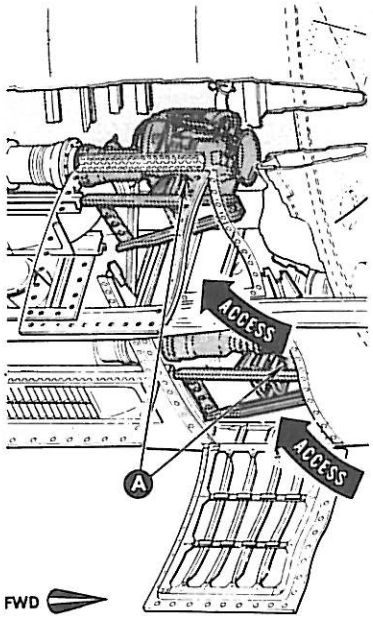
(5) Perform operational test of indicator (refer to Adjustment/Test Bearing Temperature Indicator).

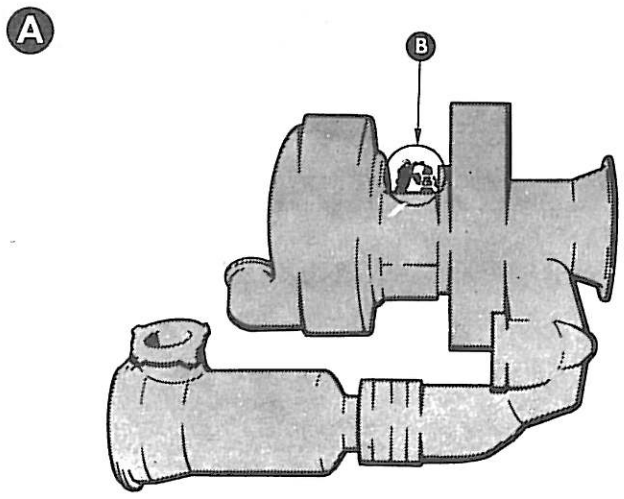
2. Adjustment/Test Turbocompressor Bearing Temperature Indicator

A. Equipment Required.

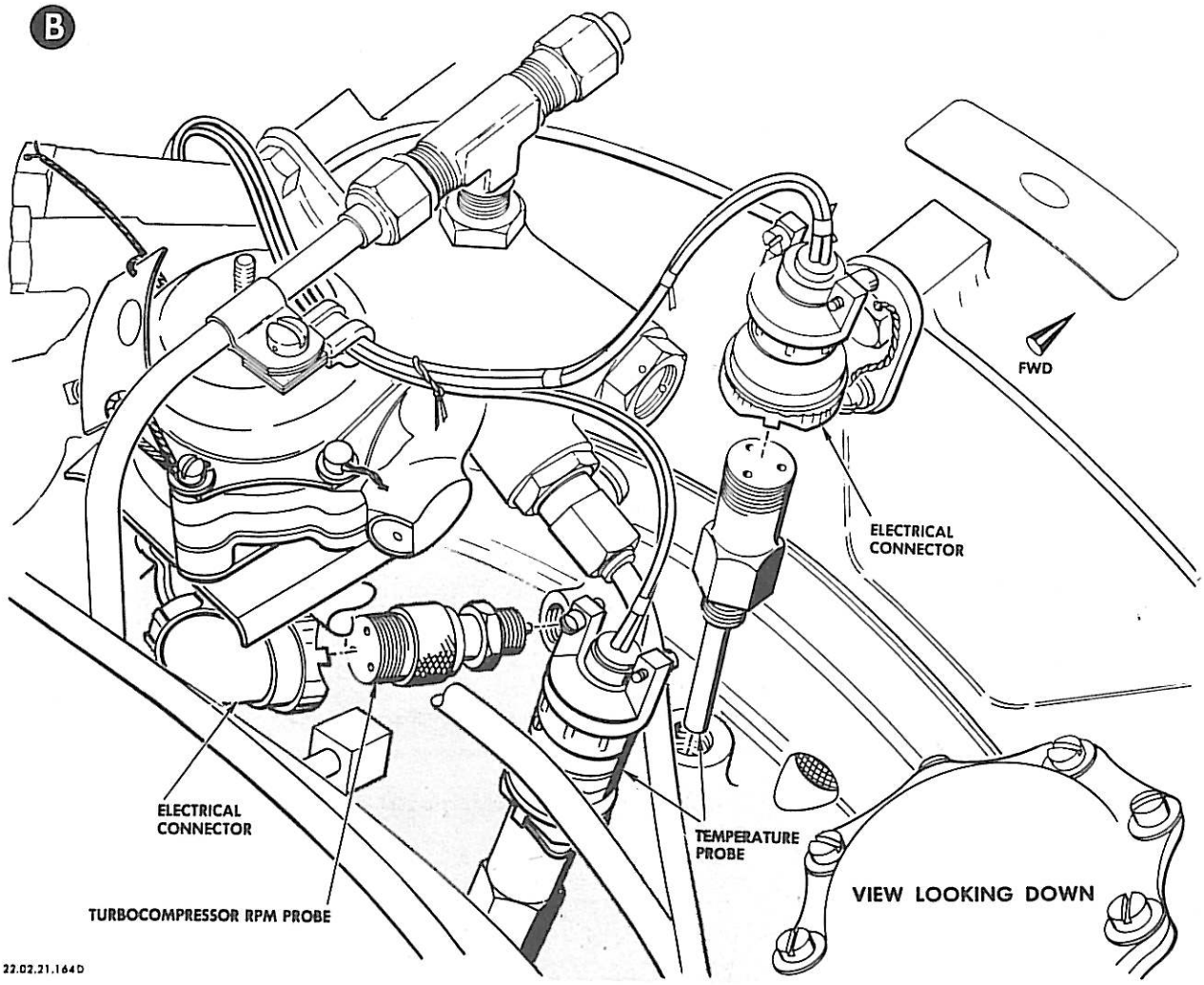
(1) External source of 115/200-volt, 3-phase, 400 cycle ac electrical power (refer to Chapter 24, ELECTRICAL POWER).

(2) Variable Resistor calibrated to test points specified in Table 1.





TURBOCOMPRESSOR



Turbocompressor Temperature and
RPM Probe Installation
Figure 201

TABLE I

GAGE INDICATED TEMPERATURE	LEADS C & D RESISTANCE (Ohms)	LEADS E & F RESISTANCE (Ohms)
93.3°C (200°F)	330 to 540	1000
121.1°C (250°F)	155 to 275	1000
148.9°C (300°F)	97 to 129	1000
93.3°C (200°F)	1000	330 to 540
121.1°C (250°F)	1000	155 to 275
148.9°C (300°F)	1000	97 to 129

B. Preparation.

(1) Open turbocompressor access door (cabin or flight deck).

(2) Disconnect electrical control harness from turbocompressor receptacle. (Receptacle is located under turbine exhaust.)

(3) Connect and apply external electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(4) Close TURBO COMPR INDICATOR circuit breaker (cabin or flight deck).

C. Test Turbocompressor Bearing Temperature Indicator.

(1) Connect variable resistor to pins C and D, and pins E and F on turbocompressor electrical plug (cabin or flight deck).

(2) Vary resistance to test points (pins C & D and E & F) per Table I and check COMPR BEARING TEMP indicator on flight engineer's control panel (cabin or flight deck); indicator reading shall be within tolerances specified in Table I.

(3) Open TURBO COMPR INDICATOR circuit breaker (cabin or flight deck).

(4) Remove variable resistor from turbocompressor electrical plug.

(5) Connect turbocompressor electrical harness plug to electrical receptacle.

(6) Close turbocompressor access doors.

(7) Remove external source of electrical power from airplane.

TURBOCOMPRESSOR RPM INDICATOR AND PICKUP PROBE - MAINTENANCE PRACTICES

1. Removal/Installation Turbocompressor RPM Indicator

NOTE: For removal of RPM indicator, refer to Chapter 31, INSTRUMENTS.

A. Remove RPM Pickup Probe (refer to 21-1-9, Figure 201).

(1) Remove turbocompressor package (cabin or flight compartment, as required) from airplane (refer to 21-1-1, Maintenance Practices).

(2) Remove bias altitude control (refer to 21-1-8, Maintenance Practices).

(3) Remove safety wire from lock nut on RPM probe. Probe is on left side of turbocompressor between turbine and compressor. The probe is installed pointing down and forward.

(4) Disconnect electrical connector from RPM probe. (Tag for installation.)

(5) Loosen lock nut at base of RPM probe.

(6) Using fingers, twist knurled portion of probe to back it out of housing.

(7) Cover opening to prevent entry of dust and dirt into compressor housing.

B. Install RPM Pickup Probe (refer to 21-1-9, Figure 201).

(1) Screw lock nut up to knurled portion of probe.

(2) Using fingers only, position probe in opening and screw in until probe touches lugs on rotating seal.

CAUTION: MAKE SURE THAT PROBE CONTACTS LUG BY SLOWLY TURNING IMPELLER. BACK OUT ON PROBE ONE-HALF TURN, HOLD IN POSITION, AND TIGHTEN LOCK NUT. ROTATE IMPELLER BY HAND TO DETERMINE THAT PROBE CLEARS ROTATING SEAL AT ALL POINTS.

(3) Install safety wire on RPM probe lock nut.

(4) Connect electrical connector to probe.

(5) Install bias altitude control (refer to 21-1-8, Maintenance Practices).

(6) Install turbocompressor package in airplane (refer to 21-1-1, Maintenance Practices).

(7) Operate turbocompressor to check indicator operation (refer to 21-0, Maintenance Practices).

HEAT CONTROL MODULATING VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Heat Control Modulating Valve (see Figure 201)

   A. Remove Heat Control Modulating Valve.

      (1) Remove turbocompressor package (refer to 21-1-1, Maintenance Practices).

      (2) Loosen coupling nuts on valve servo tube and remove tube.

      (3) Remove safety wire and disconnect electrical harness from valve actuator.

      (4) Remove nuts and screws securing clamps on flexible hose between valve and turbocompressor inlet duct; remove clamps and shield plates.

      (5) Roll flexible hose toward turbocompressor inlet to free valve.

      (6) Remove valve retaining nuts, washers and screws from transition duct and valve flanges.

      (7) Remove valve with tube union, O-ring and flexible hose.

   B. Install Heat Control Modulating Valve.

      (1) Slide new flexible hose on duct leading to overspeed control. Place both clamps on flexible hose; do not secure screws on clamps at this time.

      (2) Install tube union with new O-ring on valve pneumatic acutator.

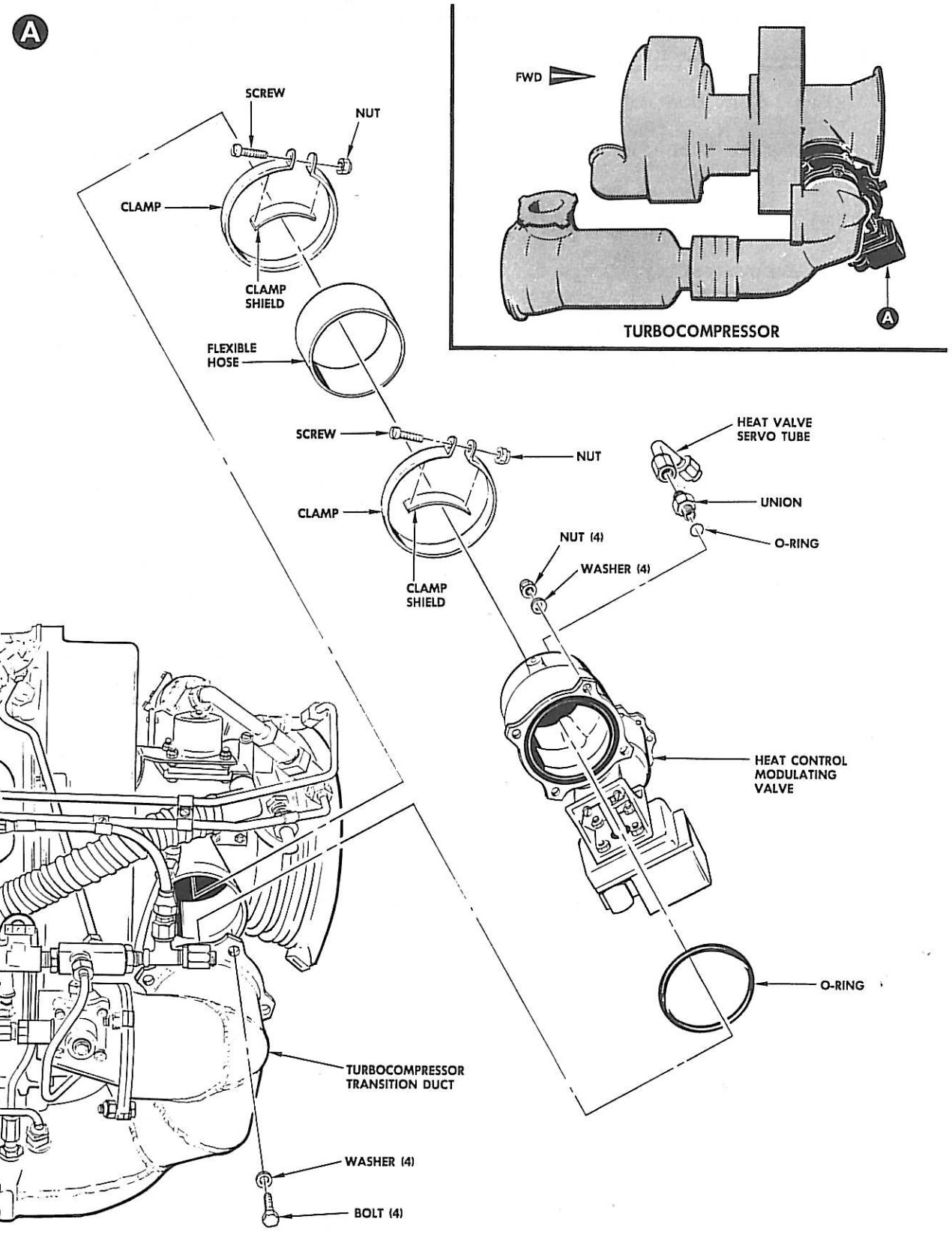
      (3) Position heat control modulating valve with new O-ring on transition duct flange.

      (4) Slide flexible hose onto valve and fasten with hose clamps. Ascertain clamp shields are installed under clamp separation before securing clamps.

      (5) Install valve servo tube; tighten coupling nuts 1/6 to 1/3 turn beyond point of initial torque rise.

      (6) Connect electrical harness to valve actuator; secure connection with safety wire.

      (7) Install turbocompressor package (refer to 21-1-1, Maintenance Practices).



Heat Control Modulating Valve Installation
Figure 201

SERVO PRESSURE SHUTOFF VALVE - MAINTENANCE PRACTICES

1. Removal/Installation Servo Pressure Shutoff Valve (see Figure 201)

   A. Remove Servo Pressure Shutoff Valve.

      (1) Remove turbocompressor package (refer to 21-1-1, Maintenance Practices).

      (2) Loosen coupling nuts and disconnect servo inlet, turbine pressure, actuator servo, and regulator inlet lines from servo pressure shutoff valve.

      (3) Remove shutoff valve mounting screws and washers.

      (4) Remove servo pressure shutoff valve, with elbows, union, and tee attached, from turbocompressor; remove shutoff valve mounting spacers.

      (5) Remove elbows, unions, tee, and O-rings from servo pressure shutoff valve; hold for installation on replacement valve.

   B. Install Servo Pressure Shutoff Valve.

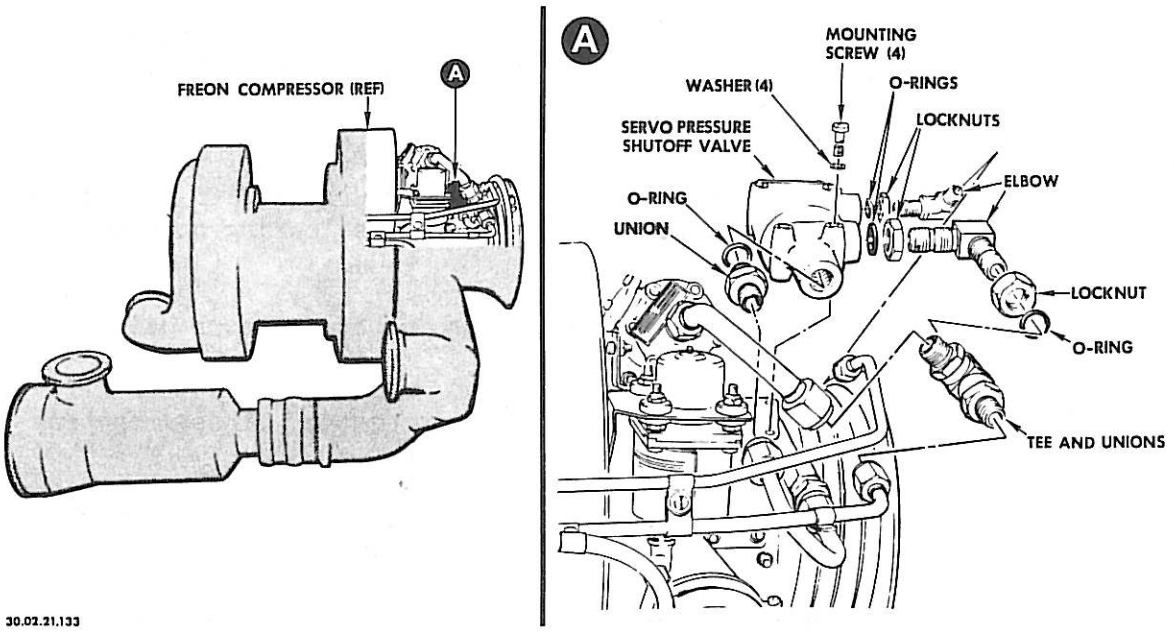
      (1) Install elbows, union and tee on servo pressure shutoff valve; use new O-rings. Tighten union fitting and leave locking nuts on elbows loose.

      (2) Install servo pressure shutoff valve on turbocompressor using mounting spacers, screws, and washers.

      (3) Position elbows to align properly with connecting lines; tighten elbow locking nuts after elbows are aligned.

      (4) Connect turbine pressure, servo inlet, actuator servo, and regulator inlet lines.

      (5) Install turbocompressor package (refer to 21-1-1, Maintenance Practices).



Servo Pressure Shutoff Valve Installation
Figure 201

PRESSURIZATION CONTROLS AND INDICATION - DESCRIPTION AND OPERATION

1. General

Cabin pressurization, shown schematically on Figure 1, is controlled automatically by a cabin pressure controller which regulates the amount of air exhausted through two pressure regulator and outflow valves. The cabin pressure controller, shown on Figure 2, is located on the flight engineer's control panel and is completely pneumatic in operation.

In addition to the cabin pressure controller, there are control switches for manual operation of the outflow valves, a cabin altimeter, a cabin rate of climb indicator, and a differential pressure guage. Warning lights are provided to indicate closed outflow valves, and to indicate an excessively high cabin altitude.

Pressurization air is normally delivered to the cabin from two turbocompressors, but in an emergency, it can be obtained directly from the engine bleed air system. In either case, a steady input to pressurize the compartments is available. The pressure level, or cabin altitude, is then controlled by regulating the amount of air dumped overboard through the outflow valves. The pressurized and conditioned air, prior to being discharged through the forward outflow valve and electronic equipment cooling valve, is used to cool the electronic and electrical equipment compartment. See Figure 3.

For normal operation of the cabin pressure control system the pressure regulator switches are placed in the AUTO position. This permits automatic (pneumatic) regulation when airborne. A ground safety relay connects the AUTO and OPEN position of each switch to electrically open the valves when on the ground. See Figure 4. The two valves are opened by separate circuits to minimize the possibility of having a pressurized cabin after landing.

2. Cabin Pressure Controller

A. Description.

The cabin pressure controller, shown on Figure 5, is located on the flight engineer's control panel. The main dial and pointer indicate the selected cabin altitude within the range of minus 1,000 to plus 10,000 feet. The inner dial indicates the maximum flight altitude at which the selected cabin altitude can be maintained. The dial in the upper right side is the barometric correction scale, and is calibrated in inches of mercury. The CABIN ALT control knob is used to set the desired cabin altitude on the main dial. The BAR CORR knob is used to correct the unit to the existing barometric pressure at the point of departure and destination. The RATE control knob is used to establish the rate of climb or descent in cabin altitude; the RATE knob can be set to maintain any rate between 50 and 2,000 feet per minute.

B. Operation.

The cabin pressure controller is used in conjunction with two cabin pressure regulator and outflow valves. It controls the valves by varying the reference pressure to the pneumatic relay in each valve. A normal allowable cabin pressure differential of 8.30 psi will provide a sea-level cabin altitude up to an airplane altitude of approximately 20,500 feet. An 8,000 foot cabin altitude can be maintained at an airplane altitude of 41,000 feet.

The cabin pressure controller has three separate pressure controlling systems or modes of operation. They are a selective pressure rate of change, a variable isobaric, and a fixed differential pressure system. These systems operate one at a time to establish the reference pressure, and the transition from one to another is automatic.

(1) Selective Pressure Rate-of-Change Control.

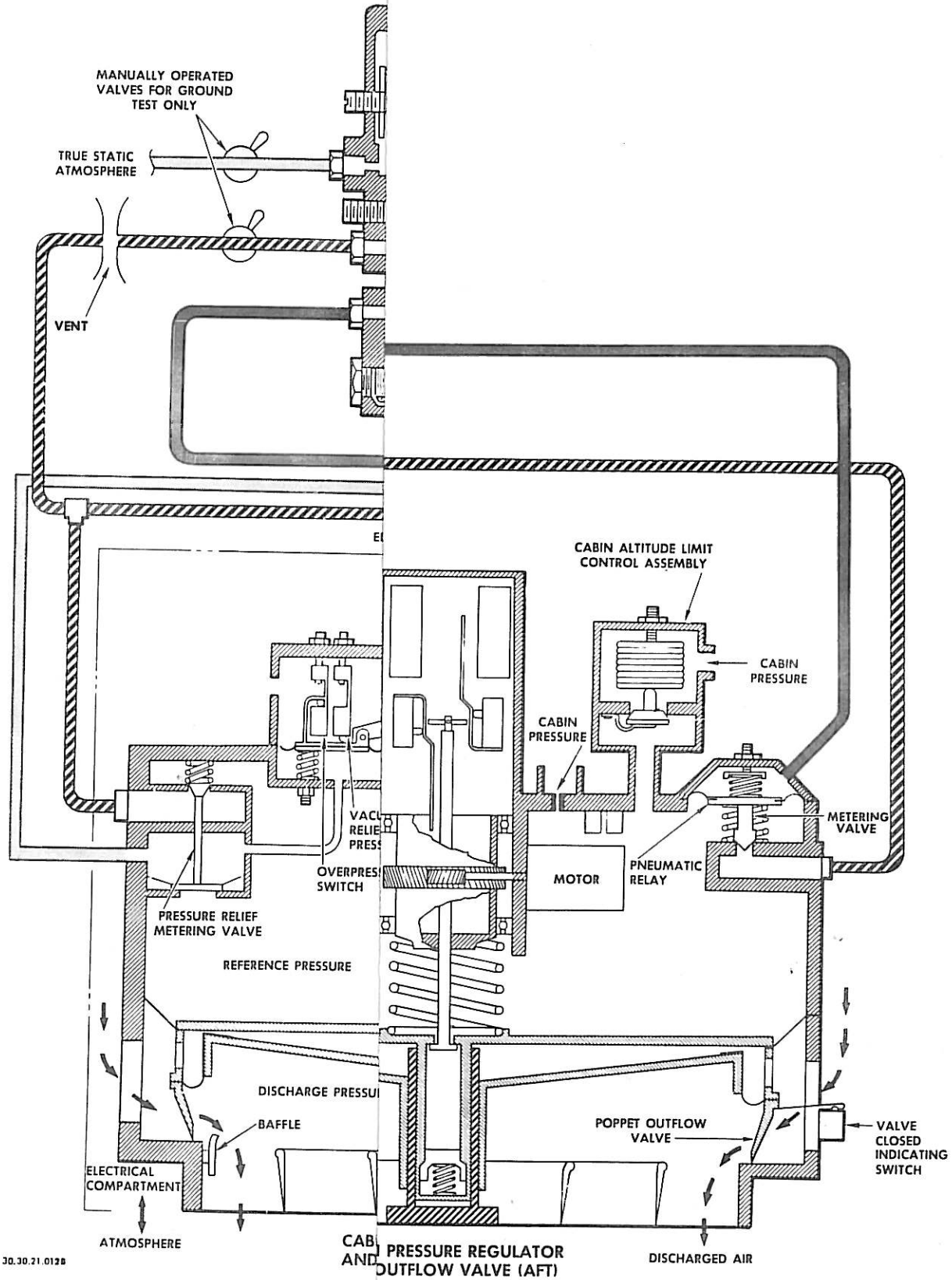
The selective pressure rate-of-change control system consists of the rate control spring, a rate control diaphragm which separates the housing into two chambers, and a connecting drilled passage with a filter, capillary tube, and rate chamber metering valve.

If the airplane rate of climb exceeds the selected rate, reference pressure is reduced, resulting in a pressure differential across the rate control diaphragm because of the capillary tube and rate chamber metering valve position. The rate control diaphragm then moves the isobaric metering valve to limit flow of air from the reference chamber until reference pressure and rate pressure equalize. The outflow valve reacts to control the rate of change of cabin pressure accordingly.

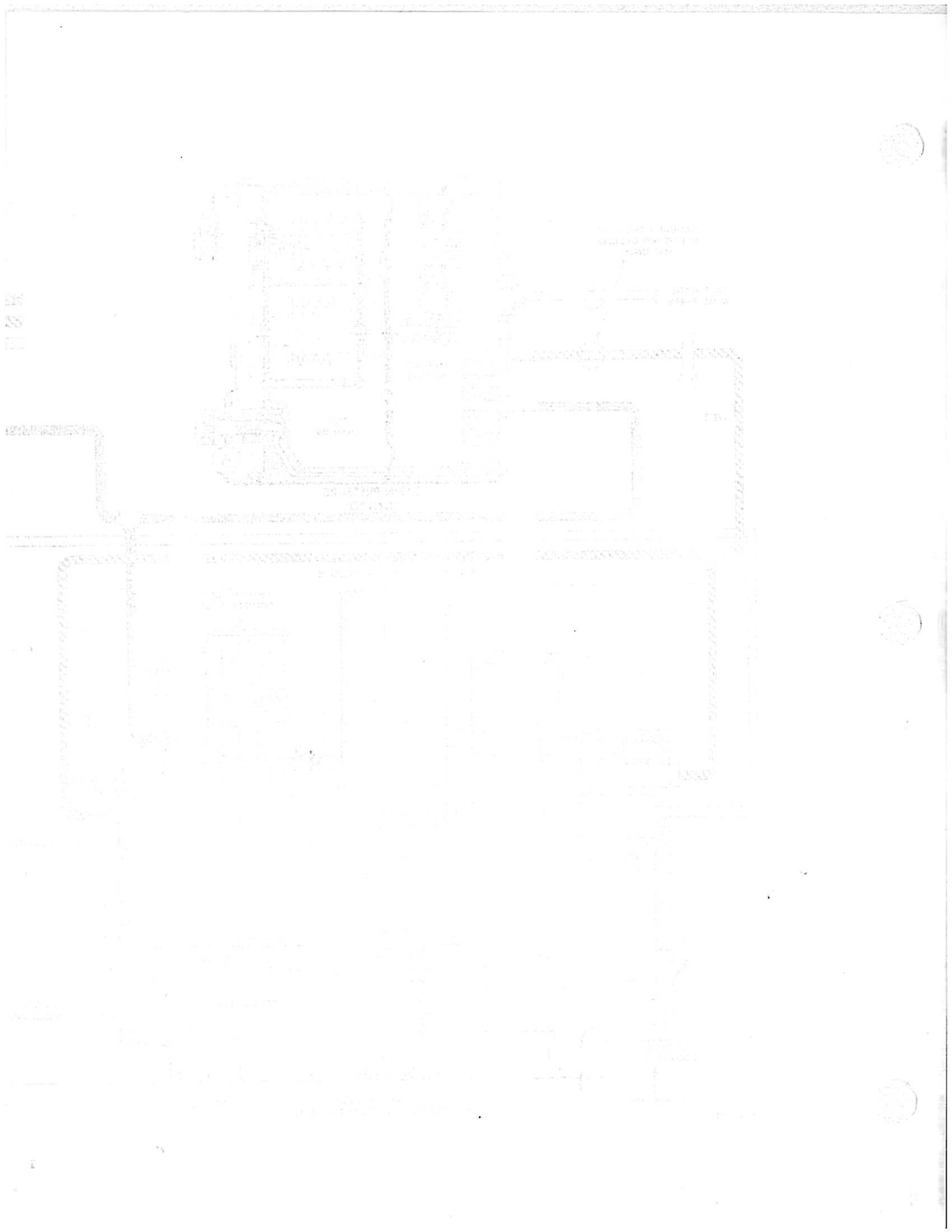
(2) Isobaric Control.

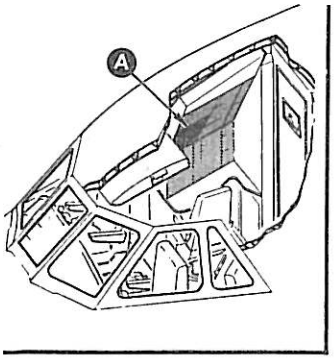
The variable isobaric control system consists of an evacuated bellows and rocker arm which are connected to a metering valve through a rate control spring. An isobaric calibration spring and calibration screw are secured to the rocker arm, and are indexed to a cabin altitude pointer through a gear train.

As the airplane enters the isobaric operating range, the bellows expands sufficiently to override the rate control diaphragm and assume control of the metering valve. With reference chamber pressure maintained essentially constant by the bellows and metering valve, reference pressure in the outflow valve remains constant. Variations in cabin pressure act directly to position the outflow valve, controlling cabin pressure at selected altitude.

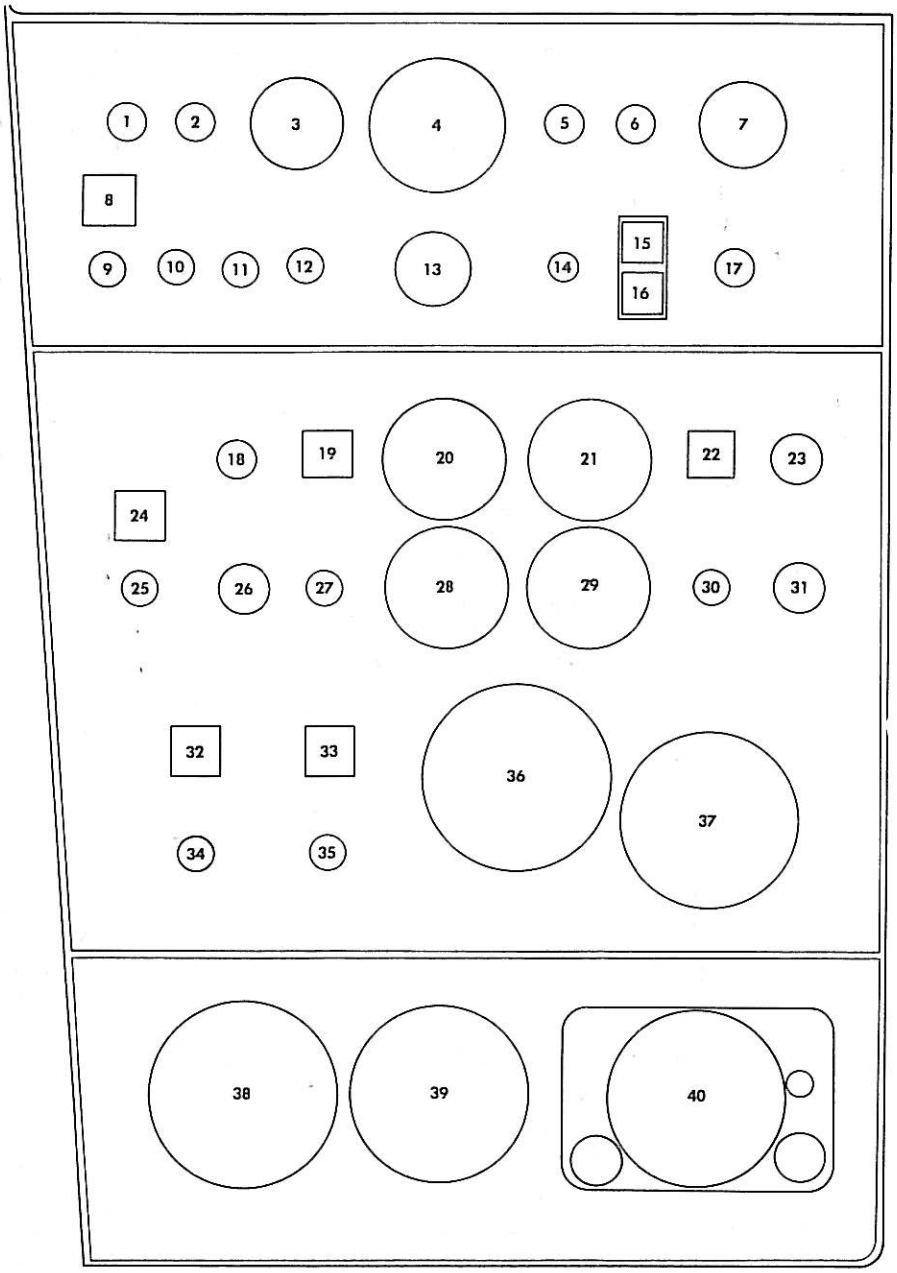


ontrol Schematic (Pneumatic)
Figure 1





A



EFFECTIVITY	
APPLICABLE TO AIRPLANES	
*	CV-1 THROUGH CV-25.
**	CV-35 AND ON.

1. FLIGHT DECK MANUAL TEMPERATURE CONTROL SWITCH
2. FLIGHT DECK AUTOMATIC TEMPERATURE CONTROL SWITCH
3. FLIGHT DECK TEMPERATURE SELECTOR
4. TEMPERATURE INDICATOR
5. CABIN MANUAL TEMPERATURE CONTROL SWITCH
6. CABIN AUTOMATIC TEMPERATURE CONTROL SWITCH
7. CABIN TEMPERATURE SELECTOR
8. ELECTRONIC COMPARTMENT COOLING LOW-AIRFLOW WARNING LIGHT
9. ELECTRONIC EQUIPMENT COOLING FAN SWITCH
10. ELECTRONIC COMPARTMENT COOLING VALVE SWITCH
11. CABIN/FLIGHT DECK FREON RESET SWITCH
12. CABIN TEMPERATURE EQUALIZATION CONTROL SWITCH
13. TEMPERATURE INDICATOR SELECTOR
14. FREON MASTER CONTROL SWITCH
15. FLIGHT DECK FREON COMPRESSOR FAIL WARNING LIGHT
16. CABIN FREON COMPRESSOR FAIL WARNING LIGHT
17. CABIN-BOTH-FLIGHT DECK FREON PACK CONTROL SWITCH
18. RECIRCULATION AIR BLOWER CONTROL SWITCH
19. FLIGHT DECK TURBOCOMPRESSOR OVERSPEED WARNING LIGHT
20. FLIGHT DECK TURBOCOMPRESSOR R.P.M. INDICATOR
21. CABIN TURBOCOMPRESSOR R.P.M. INDICATOR
22. CABIN TURBOCOMPRESSOR OVERSPEED WARNING LIGHT
23. RAM AIR VALVES CONTROL SWITCH
24. CABIN HIGH-ALTITUDE WARNING LIGHT
25. CABIN HIGH ALTITUDE WARNING HORN CUTOFF SWITCH
26. FLIGHT DECK EMERGENCY PRESSURE SOURCE SWITCH
27. FLIGHT DECK TURBOCOMPRESSOR CONTROL SWITCH
28. FLIGHT DECK TURBOCOMPRESSOR BEARING TEMPERATURE INDICATOR
29. CABIN TURBOCOMPRESSOR BEARING TEMPERATURE INDICATOR
30. CABIN TURBOCOMPRESSOR CONTROL SWITCH
31. CABIN EMERGENCY PRESSURE SOURCE SWITCH
32. FORWARD OUTFLOW VALVE VALVE-CLOSED WARNING LIGHT
33. AFT OUTFLOW VALVE VALVE-CLOSED WARNING LIGHT
34. FORWARD OUTFLOW VALVE CONTROL SWITCH
35. AFT OUTFLOW VALVE CONTROL SWITCH
36. CABIN/FLIGHT DECK TURBOCOMPRESSOR AIRFLOW INDICATOR
*37. CABIN DIFFERENTIAL PRESSURE INDICATOR
**37. CABIN DIFFERENTIAL PRESSURE AND CABIN ALTIMETER INDICATOR
*38. CABIN RATE-OF-CLIMB INDICATOR
*39. CABIN ALTIMETER
**39. CABIN RATE-OF-CLIMB INDICATOR
40. CABIN PRESSURE CONTROLLER (INCLUDES CABIN ALTITUDE CONTROL, RATE OF CLIMB OR DESCENT CONTROL, AND BAROMETRIC PRESSURE CONTROL)

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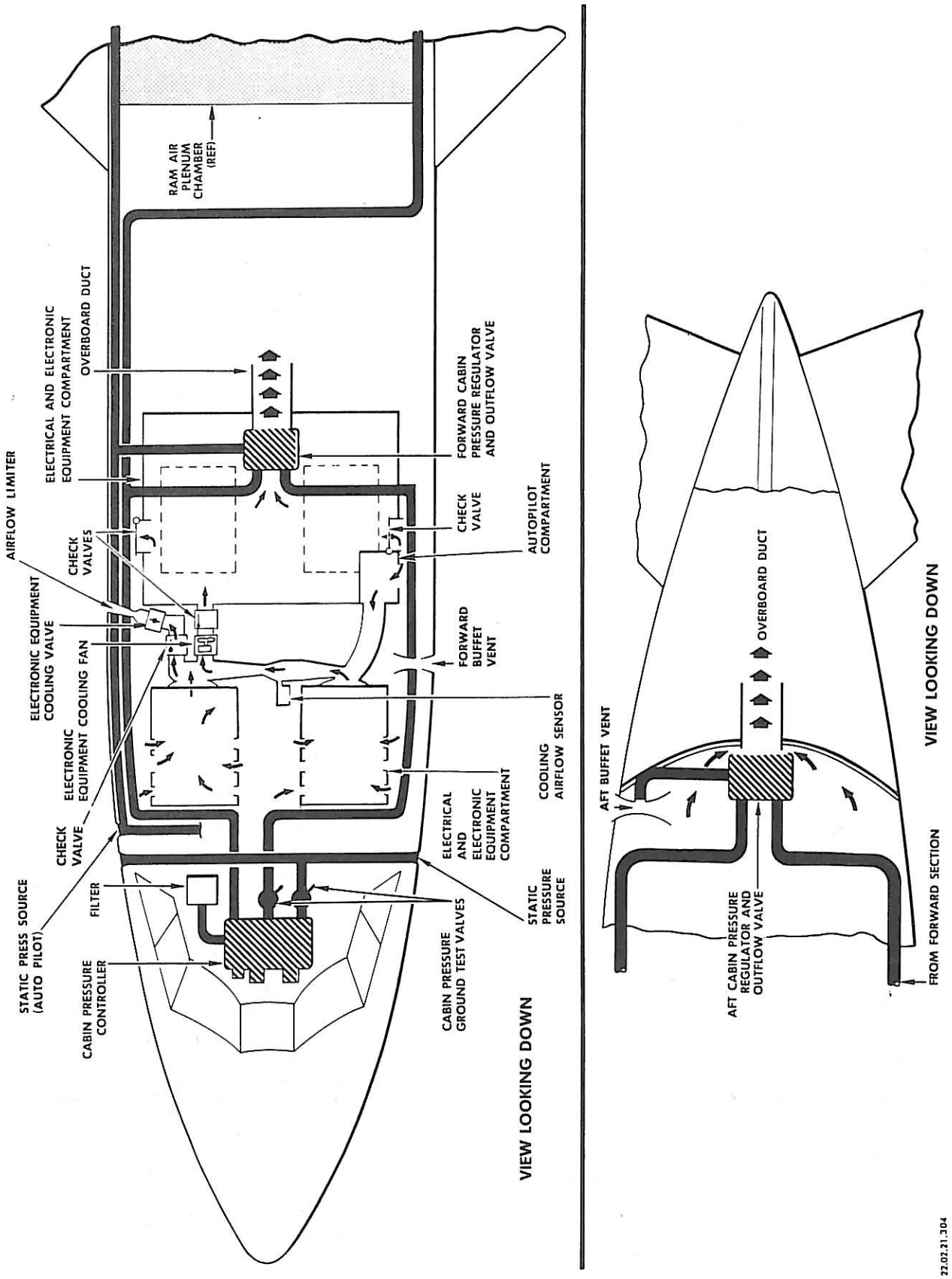
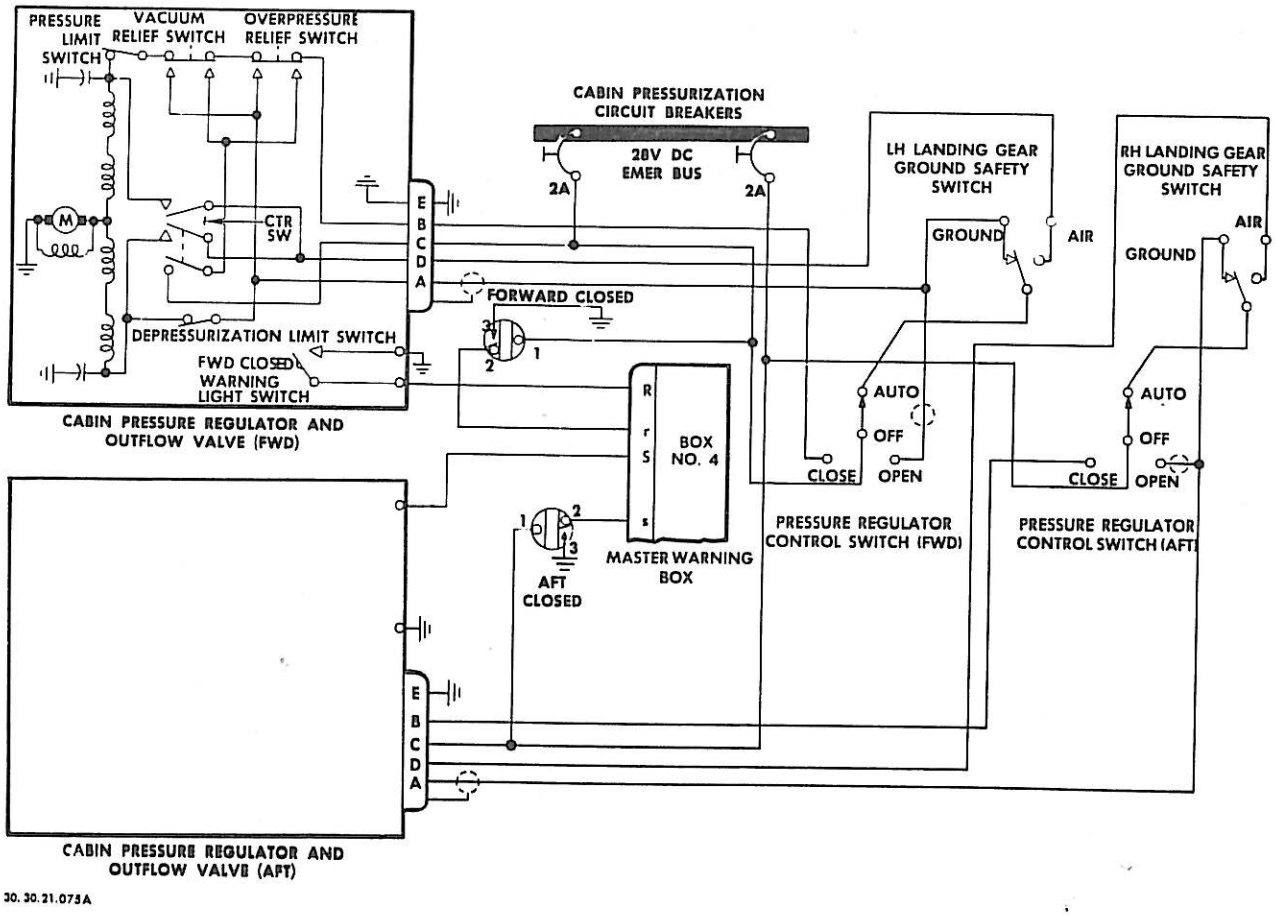
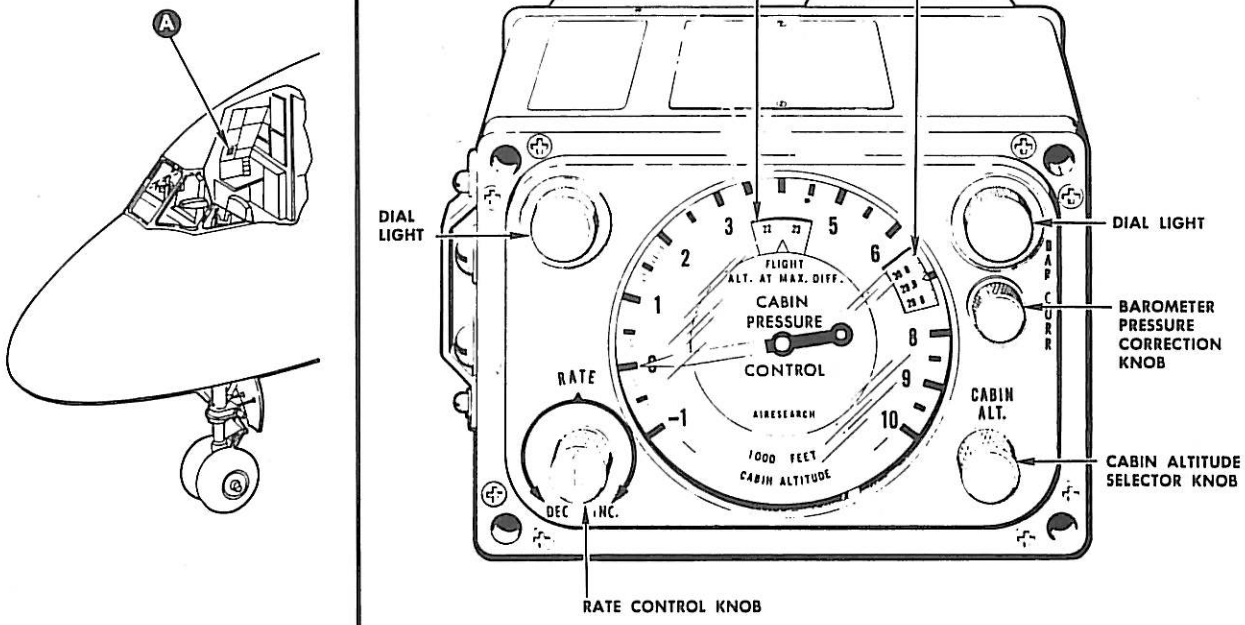
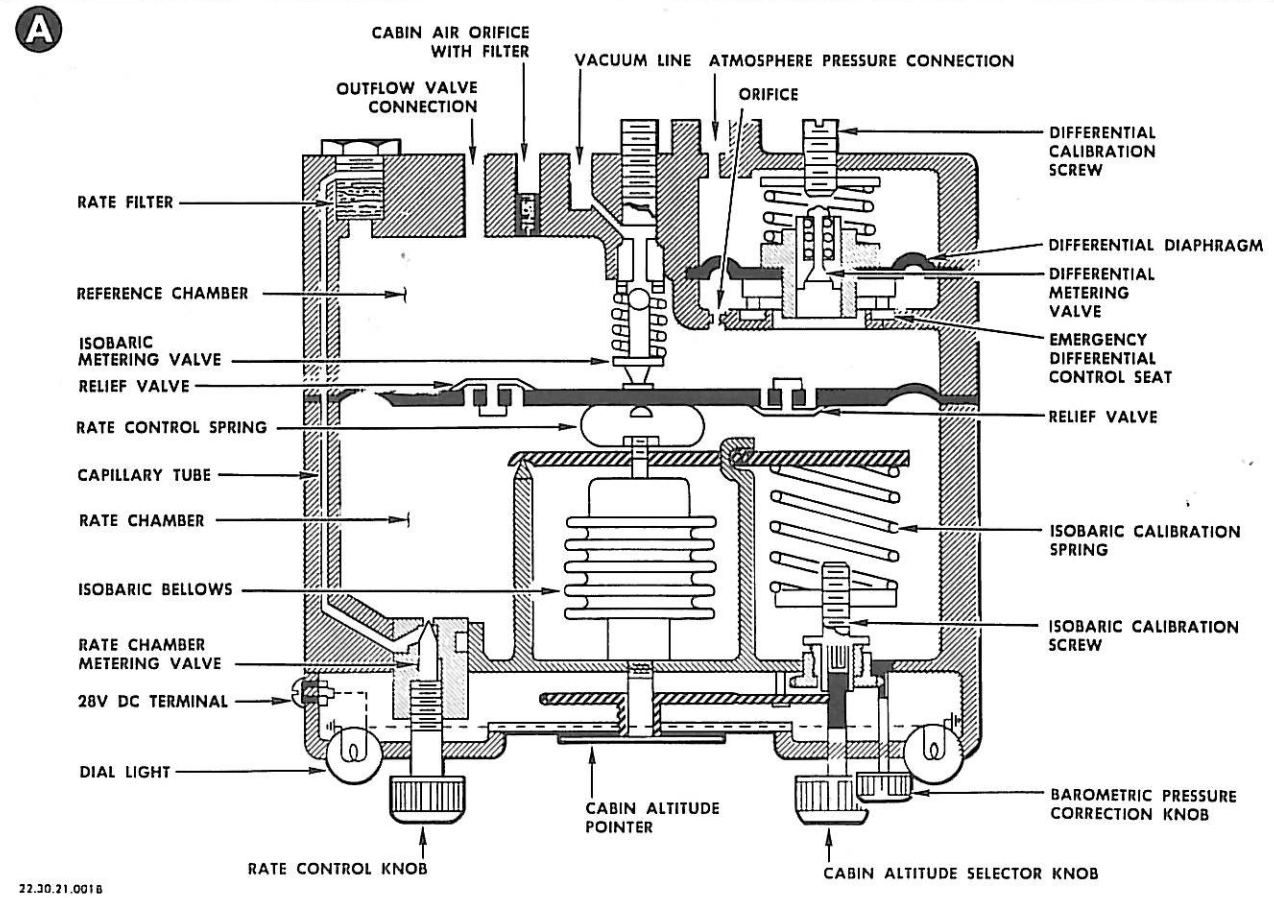
Air Conditioning and Pressurization
Control Panel
Figure 2



Pressurization Control Valves and Vents (Schematic)
Figure 3


PRESSURE LIMIT SWITCH
VACUUM RELIEF SWITCH
OVERPRESSURE RELIEF SWITCH
CTR SW
DEPRESSURIZATION LIMIT SWITCH
FWD CLOSED WARNING LIGHT SWITCH
CABIN PRESSURE REGULATOR AND OUTFLOW VALVE (FWD)
CABIN PRESSURE REGULATOR AND OUTFLOW VALVE (AFT)
E B C D A
CABIN PRESSURIZATION CIRCUIT BREAKERS
28V DC EMER BUS
2A
2A
FORWARD CLOSED
AFT CLOSED
R r S s
BOX NO. 4
MASTER WARNING BOX
LH LANDING GEAR GROUND SAFETY SWITCH
RH LANDING GEAR GROUND SAFETY SWITCH
GROUND
AIR
AUTO
OFF
CLOSE
OPEN
PRESSURE REGULATOR CONTROL SWITCH (FWD)
PRESSURE REGULATOR CONTROL SWITCH (AFT)
30.30.21.073A





Cabin Pressure Controller
Figure 5

(3) Fixed Differential Control.

The fixed differential control system consists of a spring-loaded diaphragm, a metering valve and a calibration screw. One side of the differential diaphragm is vented to atmospheric pressure and the other side of the differential diaphragm is exposed to reference pressure. This system also incorporates a fail safe feature consisting of an emergency differential control seat and orifice.

The differential control serves to control reference pressure in order that the outflow valve will establish an essentially constant pressure differential between cabin and atmosphere. As the airplane enters the differential operating range, the pressure differential between reference chamber and atmosphere allows the differential diaphragm to open the differential metering valve and release reference chamber air to atmosphere. The fail safe feature prevents loss of reference pressure in the event of a ruptured differential diaphragm by sealing the differential diaphragm from the reference chamber, permitting only a small loss of reference chamber air through the orifice. During a rapid descent, the differential metering valve closes because of increased atmospheric pressure. If the resultant rate of increase in reference pressure exceeds the selected rate, the rate control diaphragm moves the isobaric metering valve to a metering position and air from the reference chamber is bled to atmosphere. The outflow valve reacts to the reference pressure by limiting the rate of increase in cabin pressure

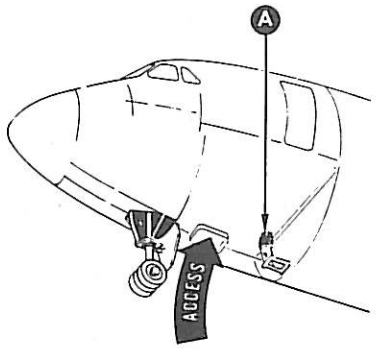
3. Cabin Pressure Regulator and Outflow Valve

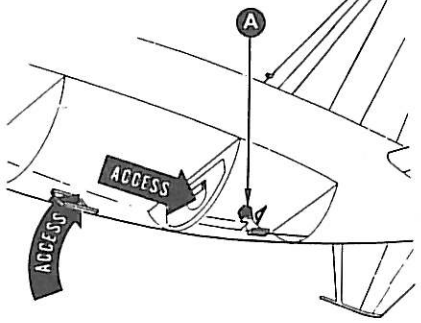
A. Description.

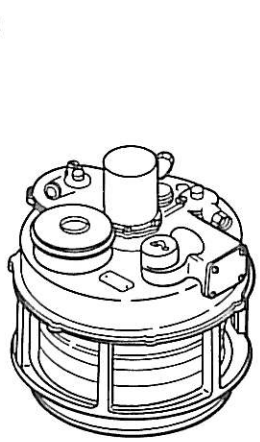
Two cabin pressure regulator and outflow valves are installed to maintain the desired pressure level within the airplane and are shown on Figure 6. The forward outflow valve is located on the floor of the electrical compartment, and the aft outflow valve is located below the aft lavatory. Both valves are mounted on short transition ducts which adapt the circular valve outlets to rectangular discharge ports in the fuselage skin. The two valves are identical except for a coarse screen which is wrapped around the forward valve. The screen will prevent the electrical compartment curtain from being sucked into the valve assembly should the curtain come loose. (Applicable to airplanes CV-7 through CV-24, the aft outflow valve is also covered with a protective screen).

B. Operation.

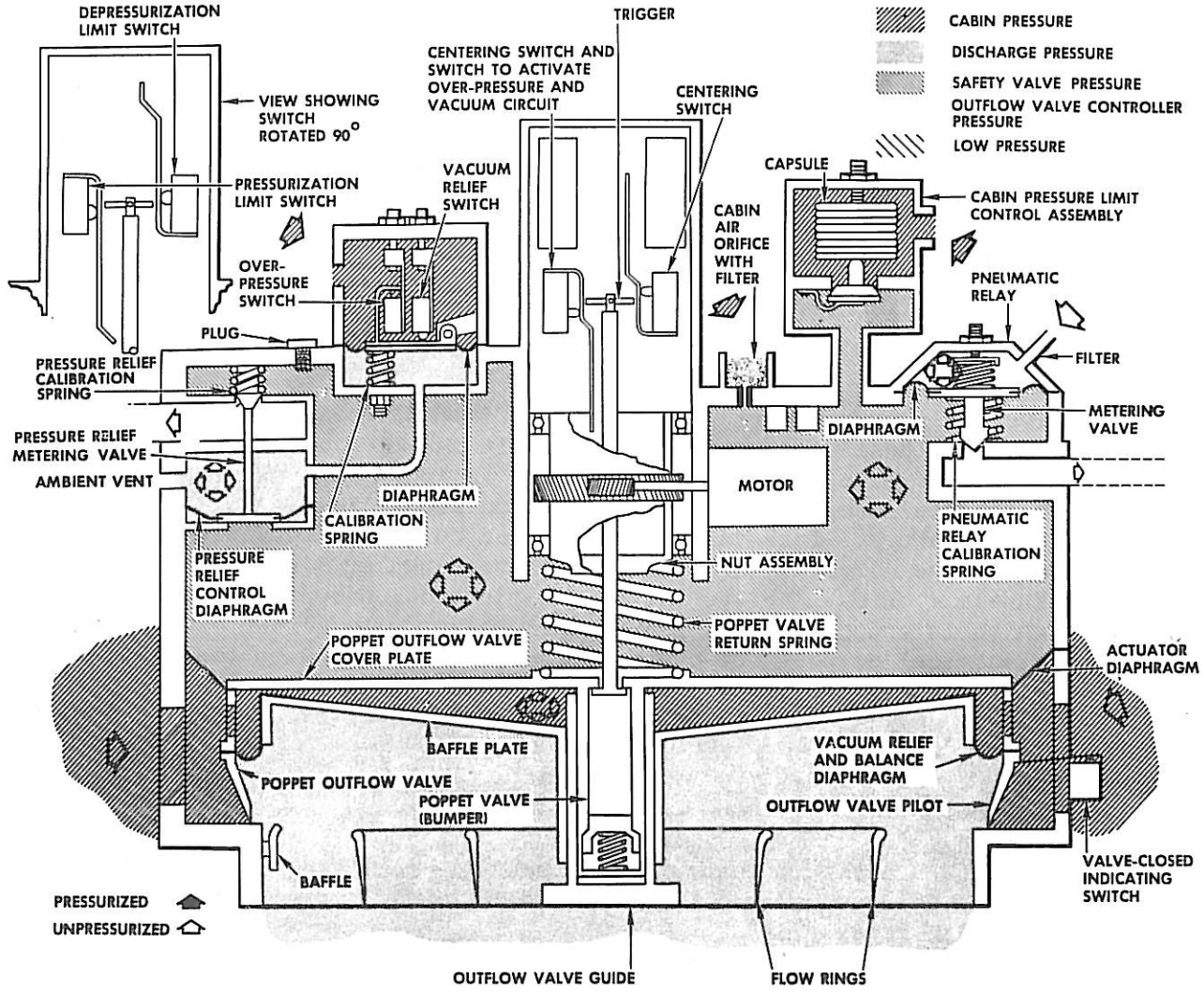
The cabin pressure regulator and outflow valves control the pressurization level, or cabin altitude by regulating the amount of air exhausted from the pressurized compartments. They also serve as pressure relief, vacuum relief and dump valves.







CABIN PRESSURE REGULATOR AND OUTFLOW VALVE ASSEMBLY



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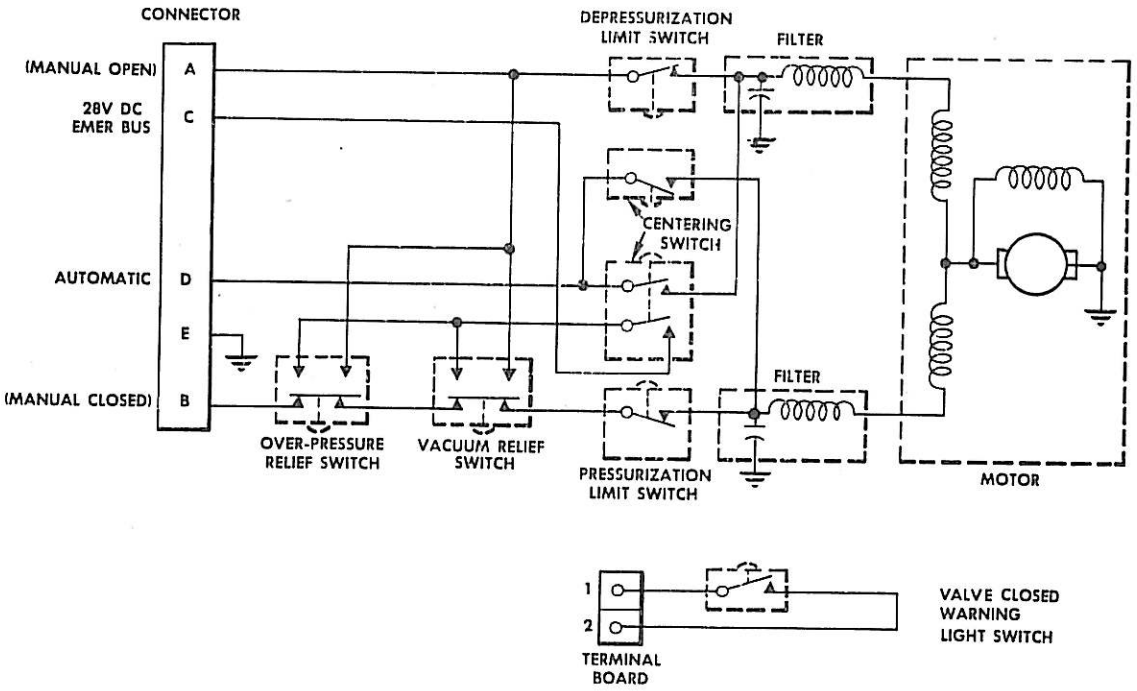


Cabin Pressure Regulator and Outflow Valve
Figure 6 (Sheet 2 of 2)

When operated in the automatic mode (pneumatic), the position of each outflow valve is determined by cabin and ambient pressure opposing a reference pressure and a poppet valve return spring (see Figure 6). Both cabin pressure and ambient pressure tend to force the valve toward the open position. The poppet valve return spring provides a constant closing force. This leaves the reference pressure as the main variable for control purposes. When reference pressure is increased, the outflow valve is moved toward the closed position to restrict the cabin outflow. This leads to a corresponding increase in cabin pressure. Decreasing reference pressure will allow the outflow valve to move toward the open position and will decrease cabin pressure.

In order to permit automatic (pneumatic) operation of the cabin pressure limiting controls, a reference pressure which is slightly below cabin pressure must be established. This reference or low pressure is created by venturi tubes through which lavatory ventilating air is passed. There are four control devices, shown in Figure 6, which can affect the reference pressure. They are, from left to right, the pressure relief metering valve, cabin air orifice, cabin pressure limit control and the pneumatic relay.

The pressure relief metering valve is actuated by a diaphragm which limits reference pressure in relation to ambient pressure. This is to prevent excessive reference pressure from holding the outflow valve closed, and thus destroying the pressure relief function. The pressure relief metering valve will limit cabin pressure to 8.50 (±0.1) psig.

The cabin air pressure is admitted to the reference chamber through a calibrated orifice. The incoming air passes through a filter designed to remove dust and tobacco smoke. This prevents dirt and tar accumulations that might clog the orifice or cause moving parts of the valve assembly to stick. The pneumatic relay works in conjunction with the cabin air orifice to maintain the desired reference pressure. Acting on a pneumatic signal from the cabin pressure controller, the pneumatic relay controls reference pressure by regulating the amount of air vented to the vacuum line.

The cabin pressure limit control assembly is calibrated to limit cabin altitude to 13,000 (±2,000) feet. It contains a sealed capsule (bellows) and a normally closed poppet valve. When cabin pressure decreases to the calibrated value, the sealed capsule will expand and open the poppet valve. This will allow cabin pressure to flow into the reference chamber and close the outflow valve poppet.

Since the forward outflow valve is contained within the electrical compartment, its operation depends upon the pressure sensed in the electrical compartment. When the electronic cooling valve is opened, electrical compartment pressure is reduced. This will have the same effect on the forward outflow valve as an excessively high cabin altitude, and will cause the valve to move toward the closed position. The forward outflow valve will, in normal operation, remain closed or nearly closed because the electronic cooling valve will exhaust most of the air. If the aft outflow valve is closed by a malfunction, then the forward outflow valve will automatically open to regulate cabin pressure for the entire airplane.

(1) Outflow Valve Manual Operation.

The outflow valve may be positioned by means of an electric motor which will override all of the previously mentioned pneumatic controls. The switch which controls the motor operation has four positions; AUTO, OFF, OPEN, and CLOSED. The OPEN and CLOSED positions are spring-loaded for momentary use, and can be used to place the outflow valve in any position. Holding the switch in the OPEN position will apply 28-volt dc power to terminal A of the valve assembly; see Sheet 2 of Figure 6. The motor will turn in the direction that raises the jack screw, and open the outflow valve. When the jackscrew reaches the limit of travel, the depressurization limit switch is opened; see Figure 6. In a similar manner, power applied to terminal B will close the outflow valve. Travel in this direction is limited by the pressurization limit switch.

(2) Outflow Valve Automatic Operation.

For automatic operation of the outflow valve, power is applied to terminal D. If the jackscrew is in the center position, no action will take place. If the jackscrew is not centered, the appropriate centering switch will energize the motor and run it in the direction necessary for centering. It will stop with the jackscrew centered to permit automatic (pneumatic) operation.

Terminal C is energized at all times to permit the over-pressure and vacuum relief switches to operate. When the jackscrew is anywhere between the center position and the closed (down) position, the centering switch will connect terminal C to the over-pressure and vacuum relief switches. Then, if pressure or vacuum relief is required, the appropriate switch will route 28-volt dc power to the motor and drive the jackscrew back to the center position.

4. Valve Closed Warning Light Switch

Each pressure regulating outflow valve contains a switch which controls the operation of its respective FWD or AFT CLOSED warning light. The switch contacts are closed when the outflow valve poppet is within 1/32 of an inch of the closed position.

PRESSURIZATION CONTROLS AND INDICATION - TROUBLE SHOOTING

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
1. CABIN FAILS TO PRESSURIZE	
A. Cabin altitude selector knob improperly positioned.	Adjust cabin altitude selector knob to obtain pressurization.
B. Clogged filter on cabin pressure control or cabin pressure regulator and outflow valve.	Clean and replace filters on cabin pressure control and on both cabin pressure regulator and outflow valves.
C. Electrical malfunction.	Check security of electrical connections on outflow valve. Check wiring through manual control switch and landing gear ground safety relay. If proper voltage is presented at the connector of the outflow valve, and the valve cannot be controlled manually (electrically) replace the outflow valve.
D. Foreign object holding outflow valve open.	Check visually, and remove any obstruction.
E. Access door(s) not closed and/ or not sealing properly.	Check that all doors are closed and sealing properly. Check particularly the nose wheel well access door for proper engagement of latching pin.
2. CABIN PRESSURE CONTROL SYSTEM FAILS TO MAINTAIN THE SELECTED CABIN ALTITUDE	
A. Clogged filter on cabin pressure control or on the cabin pressure regulator and outflow valves.	Clean and replace filter on the cabin pressure control and on both cabin pressure regulator and outflow valves (refer to PRESSURIZATION CONTROLS AND INDICATION - MAINTENANCE PRACTICES).
B. Loose or damaged pneumatic tubing between cabin pressure control and the cabin pressure regulator and outflow valve.	Check security of tubing connections. Check tubing for leaks. (Do not pressure test tubing when connected to controller or to the outflow valves.)

POSSIBLE CAUSE	ISOLATION PROCEDURE AND CORRECTION
2. CABIN PRESSURE CONTROL SYSTEM FAILS TO MAINTAIN THE SELECTED CABIN ALTITUDE (CONT)	
C. Obstructed lavatory vents.	Check that lavatory vents are not obstructed by debris.

WARNING: MAINTENANCE PERSONNEL ARE LIMITED TO THE PRECEDING CORRECTIVE MEASURES. DO NOT ATTEMPT TO MAKE ADJUSTMENTS ON THE BACK OF THE CABIN PRESSURE CONTROL OR ON THE CABIN PRESSURE REGULATOR AND OUTFLOW VALVES. IF THE ABOVE MEASURES DO NOT CORRECT THE MALFUNCTION, THE CABIN PRESSURE CONTROL OR THE OUTFLOW VALVES MUST BE REPLACED.

PRESSURIZATION CONTROLS AND INDICATION - MAINTENANCE PRACTICES

1. Adjustment/Test

A. General.

The following procedures are used to test the operation of several critical items in the pressurization control system which cannot be tested during normal flight operations. This test may also be performed when any component of the pressurization control system is replaced, or when any structural components which may affect cabin pressurization have been replaced or repaired. Since most of the safety features in the pressurization system are duplicated, or backed up by another device, the failure of one item may not be detected by the flight crew. The airplane would not experience any trouble until the second similar failure occurred. The following tests will permit early detection of individual malfunctions, and they will prevent an accumulation of malfunctioning components which could eventually endanger the airplane and its occupants.

B. Equipment Required.

(1) An external source of air pressure capable of delivering approximately 50 pounds per minute airflow at 17.5 inches of mercury at a temperature not greater than 170 degrees F (76.7 degrees C). The rate of flow shall be adjustable from zero to full capacity. Pressure at airplane connection shall not be allowed to exceed 40 (±5) psig.

WARNING: THIS AIR WILL BE ROUTED THROUGH THE FREON EVAPORATOR WHERE TEMPERATURES IN EXCESS OF 170 DEGREES F (76.7 DEGREES C) ARE NOT PERMITTED. THIS LIMITATION APPLIES WHETHER THE FREON PACKAGE IS OPERATING OR NOT.

(2) External source of 115/200 volts, 400 cycle, three phase electrical power (refer to Chapter 24, ELECTRICAL POWER).

(3) A mercury manometer with connecting tubing for attachment to test connection in nose wheel well. Tubing must connect with an MS-21903D6 fitting in airplane.

(4) Intercom equipment for communication between persons inside and outside of the airplane.

(5) Caps to seal pressure sensing ports on cabin vertical speed indicator (Caps must withstand 8.6 psig without leakage.)

(6) Warning signs to prevent unauthorized personnel from attempting to open doors while the airplane is pressurized.

CAUTION: THE DOORS WILL NOT OPEN UNDER PRESSURE, BUT A DETERMINED ATTEMPT MIGHT DAMAGE THE LOCKING MECHANISM.

(7) Plugs to seal the forward and aft lavatory and buffet vents.

C. Preparation.

(1) Install caps on pressure sensing ports on cabin vertical speed indicator (refer to Chapter 31, INSTRUMENTS).

(2) Install plugs in forward and aft lavatory and buffet vents.

(3) Connect mercury manometer to fitting adjacent to CABIN PRESSURIZATION GROUND TEST valves in nose wheel well. (Adjust manometer if required.)

(4) Connect external source of electrical power to airplane (refer to Chapter 24, ELECTRICAL POWER).

(5) Place warning signs to keep unauthorized personnel away from airplane.

(6) Install and test intercom equipment to be used between the flight engineer's station and the person controlling the air pressure source.

(7) Connect air pressure source to bleed air manifold (fitting near right hand ram air inlet to air conditioning compartment).

WARNING: THIS AIR WILL BE ROUTED THROUGH THE FREON EVAPORATOR WHERE TEMPERATURES IN EXCESS OF 170 DEGREES F (76.7 DEGREES C) ARE NOT PERMITTED. THIS LIMITATION APPLIES WHETHER THE FREON PACKAGE IS OPERATING OR NOT. (SEE EQUIPMENT REQUIRED.)

(8) Place cabin pressurization ground test valve handles in RELIEF PRESS TEST position (both handles horizontal).

(9) Close forward and aft CABIN PRESSURE REGULATOR and ELEC COMPT COOLING VALVE circuit breakers.

(10) Place forward and aft PRESSURE REGULATOR switches (on flight engineer's control panel) in AUTO position.

(11) Place ELEC COMPT COOL VALVE switch in CLOSE position.

(12) Adjust cabin pressure controller to "0" cabin altitude.

(13) Place RH and LH landing gear ground safety switches in airborne position (refer to Chapter 32, LANDING GEAR).

(14) With one or more persons inside to man the flight engineer's station, close all doors, windows and hatches.

D. General Procedures.

(1) During the pressurization procedure, one person shall monitor differential pressure from the flight engineer's control panel and a second person outside the airplane shall monitor differential pressure on the mercury manometer. Either person shall be prepared to reduce cabin pressure in an emergency.

WARNING: CABIN PRESSURE SHALL NOT BE ALLOWED TO EXCEED 8.6 PSIG (17.5 INCHES OF MERCURY).

(2) Because of its greater accuracy and reliability, the mercury manometer shall be used as the primary pressure measuring instrument. The differential pressure gage on the flight engineer's control panel will serve as a backup.

(3) For the protection of persons working in the pressurized compartments pressure shall not be increased or decreased at rates in excess of 1 psig (approximately 2 inches of mercury) per minute. The rate of change in pressure can be controlled by manually operating a pressure regulating outflow valve, or by varying the flow at the air pressure source.

WARNING: REVIEW COMPANY PROCEDURES AND SAFETY REGULATIONS CONCERNING WORK IN PRESSURIZED AREAS. KNOW IN ADVANCE THE PROCEDURE TO BE FOLLOWED IN THE EVENT OF AN INJURY FROM RAPID DECOMPRESSION. IF NO OTHER EQUIPMENT IS AVAILABLE, ANOTHER AIRPLANE CAN BE USED AS A COMPRESSION CHAMBER.

(4) Tests will be performed in the following sequence: pressurization leak test, a relief pressure test, which will check the pressure relief metering valve in both outflow valves, a differential test which will check the differential metering valve in the cabin pressure controller and a manual control test which checks electrical operation of the valve.

E. Cabin Pressurization Leak Test.

(1) Open control valve on air pressure source and slowly increase pressure.

(2) Open either one of the emergency pressurization shutoff valves by placing respective PRESS SOURCE switch in OPEN position.

CAUTION: WHEN PRESSURE REACHES 1 PSIG (2 INCHES OF MERCURY) DETERMINE THAT BOTH THE DIFFERENTIAL PRESSURE GAGE AND THE MERCURY MANOMETER REGISTER PRESSURE. IF THEY DO NOT AGREE, REDUCE PRESSURE AND CHECK INSTRUMENTATION.

(3) Regulate air pressure source to keep the rate of cabin pressure increase below 1 psig per minute (2 inches of mercury). If required, a pressure regulating outflow valve may be manually opened and then closed as pressure increases.

NOTE: If cabin temperature becomes uncomfortably warm, the Freon package on the side corresponding to the open emergency pressurization valve may be placed in operation.

(4) As cabin pressure increases, it may be necessary to open the second emergency pressurization shutoff valve. To do so, place the other PRESS SOURCE switch in OPEN position.

(5) When airplane is pressurized to 15 inches of mercury, turn off source of air supply and allow pressure to decrease normally.

(6) When pressure decreases to 11.4 inches of mercury, begin timing pressure drop with stop watch; time lapse for pressure to drop from 11.4 to 6.1 inches of mercury shall be a minimum of four minutes and 10 seconds.

(7) If pressure drops from 11.4 to 6.1 inches of mercury in less than time specified in step (6), proceed as follows:

(a) Pressurize airplane with air supply adjusted to maintain pressure at 11.4 inches of mercury.

(b) Check for leaks using bubble fluid around suspected leakage areas.

(c) Repair leaks as required (refer to applicable chapter in Maintenance Manual containing repair information on windows, doors, seals, structure etc.).

(d) When leaks have been repaired, pressurize and retest airplane per steps (5) through (7). When test is satisfactory, remove plugs from lavatory and buffet vents and proceed to relief and differential pressure tests.

F. Relief and Differential Pressure Test.

(1) Slowly increase air supply and attempt to pressurize airplane to 17.5 inches of mercury (8.6 psig).

(2) As cabin pressure differential approaches 8.5 psi (17.3 inches of mercury) determine that both PRESSURE REGULATOR switches are in AUTO position.

CAUTION: THE FORWARD AND AFT PRESSURE REGULATING OUTFLOW VALVES SHOULD OPEN AT 8.5 (±0.1) PSIG (17.3 (±0.2) INCHES OF MERCURY). CHECK FOR AIR FLOW FROM BOTH VALVES. IF ONE VALVE OPENS AT THE LOWER LIMIT, IT MAY BE IMPOSSIBLE TO INCREASE PRESSURE TO THE UPPER LIMIT. IF THIS HAPPENS, MANUALLY CLOSE ONLY THE OPEN VALVE TO BRING PRESSURE UP TO 8.6 PSIG (17.5 INCHES OF MERCURY). NEVER EXCEED 8.6 PSIG (17.5 INCHES OF MERCURY). A PRESSURE REGULATING OUTFLOW VALVE THAT FAILS TO OPEN AT THE UPPER LIMIT PRESSURE SHALL BE REPLACED.

(3) While maintaining cabin pressure place cabin pressurization ground test valve handles in DIFFERENTIAL TEST position (left handle horizontal, right handle vertical).

(4) Cabin pressure shall decrease and stabilize at 8.30 psi (16.9 inches of mercury).

(5) With both PRESS SOURCE switches in OPEN position, and air pressure source delivering full capacity, it should be impossible to increase cabin pressure above 8.30 (±0.1) psi (16.9 (±0.2) inches of mercury). If cabin pressure exceeds these limits the cabin pressure controller shall be replaced. If a new controller does not correct the trouble, a leak is indicated in the control tubing from the cabin pressure controller to the pressure regulating outflow valves.

NOTE: Cabin differential pressure indicator shall indicate applied pressure (±0.2 psig).

(6) Slowly reduce cabin pressure to zero differential.

CAUTION: DO NOT REDUCE CABIN PRESSURE AT A RATE IN EXCESS OF 1 PSIG PER MINUTE. (APPROXIMATELY 2 INCHES OF MERCURY PER MINUTE)

(7) Place both cabin pressure ground test valves in FLIGHT position (both handles vertical). Lock wire handles in FLIGHT position.

(8) Correct barometric pressure on cabin pressure controller to read sea level pressure prevailing at time of test, then adjust cabin altitude control knob to minus 1,000 feet.

(9) Slowly turn on air pressure source. Cabin pressure shall increase to approximately 0.5 psi (1 inch of mercury).

(10) Place LH and RH landing gear ground safety switches in ground position (refer to Chapter 32, LANDING GEAR).

(11) Slowly adjust cabin altitude control knob to zero altitude. Cabin pressure shall decrease to a maximum of 0.15 psig (0.3 inch of mercury). If cabin pressure remains above this limit, the cabin pressure controller (located on flight engineer's control panel) shall be replaced.

G. Outflow Valve and Warning Light Test.

(1) With the airplane depressurized and air pressure source turned off, place and hold PRESSURE REGULATOR switches in CLOSE position and check for the following:

(a) Forward and aft outflow valves shall close (check position indicators on valves).

(b) FWD and AFT CLOSED warning lights shall illuminate.

(2) Place FWD PRESSURE REGULATOR switch in AUTO position and check for the following:

(a) Forward outflow valve shall open within 14 to 35 seconds.

(b) FWD CLOSED warning light shall extinguish.

(3) Place FWD PRESSURE REGULATOR switch in OPEN position; there shall be no change in results from step (2).

(4) Place FWD PRESSURE REGULATOR switch in CLOSE position.

(a) Forward outflow valve shall close within 14 to 35 seconds.

(b) FWD CLOSED warning light shall illuminate.

(5) Repeat steps (2) through (4) substituting AFT for FWD and aft for forward.

WARNING: PRIOR TO PERFORMING STEP (6) ASCERTAIN THAT ANIT-SKID SYSTEM IS TURNED OFT AND/OR THE MAIN WHEELS ARE PROPERLY CHOCKED.

(6) With FWD and AFT PRESSURE REGULATOR switches in CLOSE position, place LH and RH landing gear ground safety switches in airborne position (refer to Chapter 32, LANDING GEAR).

(a) Forward and aft outflow valves shall remain closed.

(b) FWD and AFT CLOSED warning lights shall remain illuminated.

(7) Place FWD PRESSURE REGULATOR switch in AUTO position.

(a) Forward outflow valve shall remain closed.

(b) FWD CLOSED warning light shall remain illuminated.

(8) Place FWD PRESSURE REGULATOR switch in OPEN position.

(a) Forward outflow valve shall open.

(b) FWD CLOSED warning light shall extinguish.

(9) Place FWD PRESSURE REGULATOR switch in CLOSE position.

(a) Forward outflow valve shall close.

(b) FWD CLOSING warning light shall illuminate.

(10) Repeat steps (7) through (9) substituting AFT for FWD and aft for forward.

(11) Place LH and RH landing gear ground safety switches in groundborne position.

(12) When test is complete remove caps and connect tubing to the cabin vertical speed indicator.

(13) Remove mercury manometer connection in nose wheel well. (Cap airplane fitting.)

(14) Remove air pressure source and electrical power from airplane.

(15) Remove warning signs.

2. Leak Test Cabin Pressure Regulating and Outflow Valves and Cabin Pressure Controller Static Sensing System.

A. Equipment Required.

(1) Pitot-static test stand.

(2) Bubble fluid.

(3) Pressure caps capable of withstanding 150 psi.

B. Leak Test Cabin Pressure Regulating and Outflow Valves Static Sensing System.

NOTE: The leak test for the cabin pressure regulating and outflow valves is accomplished when testing the autopilot static system. Refer to Chapter 34, NAVIGATION, for procedure.

C. Leak Test Cabin Pressure Controller Static Sensing System.

(1) Disconnect tubing from forward venturi; venturi is on right side of forward cargo compartment.

(2) Connect vacuum line from pitot-static test stand to tubing disconconnected in step (1); connect test stand line to tubing which connects venturi to cabin pressure controller.

(3) Remove cabin pressure controller air filter (refer to 21-2-1, Maintenance Practices). Cap end of filter line at point where air filter was disconnected.

(4) Rotate CABIN ALT control knob on cabin pressure controller until cabin altitude dial indicates 10,000 feet.

(5) Adjust RATE control knob on cabin pressure controller to full INC (extreme clockwise) position.

CAUTION: IN STEP (6) DO NOT EXCEED A RATE OF CLIMB OVER 5,000 FEET PER MINUTE.

(6) Slowly apply a vacuum of 10.0 inches of mercury (19.92 inches of mercury, absolute).

(7) When vacuum stabilizes at 10.0 inches of mercury, shut off vacuum source at test stand. Allow system to remain with this vacuum for a minimum of three minutes.

(8) Pressure decay shall not exceed 0.50-inch of mercury during three minute test period.

NOTE: If indicated leakage rate exceeds 0.50-inch of mercury during test period, slowly reduce system to 0 inch of mercury (atmosphere); pressurize system to 5.00 inches of mercury (34.92 inches of mercury, absolute) and use bubble fluid to locate leaks.

(9) Repair leaks as necessary and retest system per steps (6) through (8).

CAUTION: IN STEP (10) DO NOT EXCEED A RATE OF DESCENT OVER 5,000 FEET PER MINUTE.

(10) When system proves satisfactory, slowly reduce test stand vacuum to 0 inch of mercury (atmosphere).

(11) Remove pitot-static test stand line from venturi in forward cargo compartment; connect airplane system tubing to venturi.

(12) Remove cap from cabin pressure controller air filter line and install air filter (refer to 21-2-1, Maintenance Practices).

CONVAIR MODEL 30

MAINTENANCE MANUAL

TEMPORARY REVISION NO. 21-20.

Insert facing 21-2-1, Page 201, dated Nov. 15/62 (or subsequent).

The information in this temporary revision is applicable to airplanes prior to incorporation of Convair COR 30-22019. For airplanes modified per COR 30-22019, use the information on Page 201.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted COR.

Page 201, in steps 1.A.(7) through 1.A.(10) and 1.B.(1), and the first sentence in step 1.B.(2), substitute the word "tubing" for the phrase "flexible hose or hoses".

CABIN PRESSURE CONTROLLER - MAINTENANCE PRACTICES

1. Removal/Installation Cabin Pressure Controller (see Figure 201)

A. Remove Cabin Pressure Controller.

(1) Open FLIGHT ENGINEER PANEL LTS circuit breaker.

(2) Release fasteners and open flight engineer's forward and aft hinged control panels, and the engine fuel control panel (refer to Chapter 31, INSTRUMENTS).

(3) Disconnect instrument light electrical leads from side of cabin pressure controller.

(4) Remove six screws which secure plastic edge-lighting panel to face of instrument panel; remove edge-lighting panel.

(5) Remove four screws which secure instrument panel to face of cabin pressure controller.

(6) Release fasteners which secure instrument panel to airplane structure; pull panel (with rate-of-climb indicator and/or cabin altimeter) clear of cabin pressure controller.

NOTE: Do not allow flexible line and electrical leads to support weight of instrument panel.

(7) Disconnect three flexible hose connections below cabin pressure controller; connections are approximately ten inches below controller. (Cap open ends of hoses.)

(8) Disconnect flexible hose connection at air filter. The filter is below and approximately six inches to the right of the controller.

(9) Remove controller with short pieces of flexible hose attached.

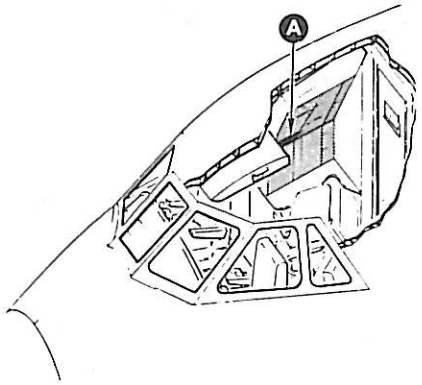
(10) Remove flexible hoses and adapter fittings from cabin pressure controller and hold for installation on replacement unit.

NOTE: Tag lines and note position of fittings on back side of controller to ensure proper positioning on replacement unit.

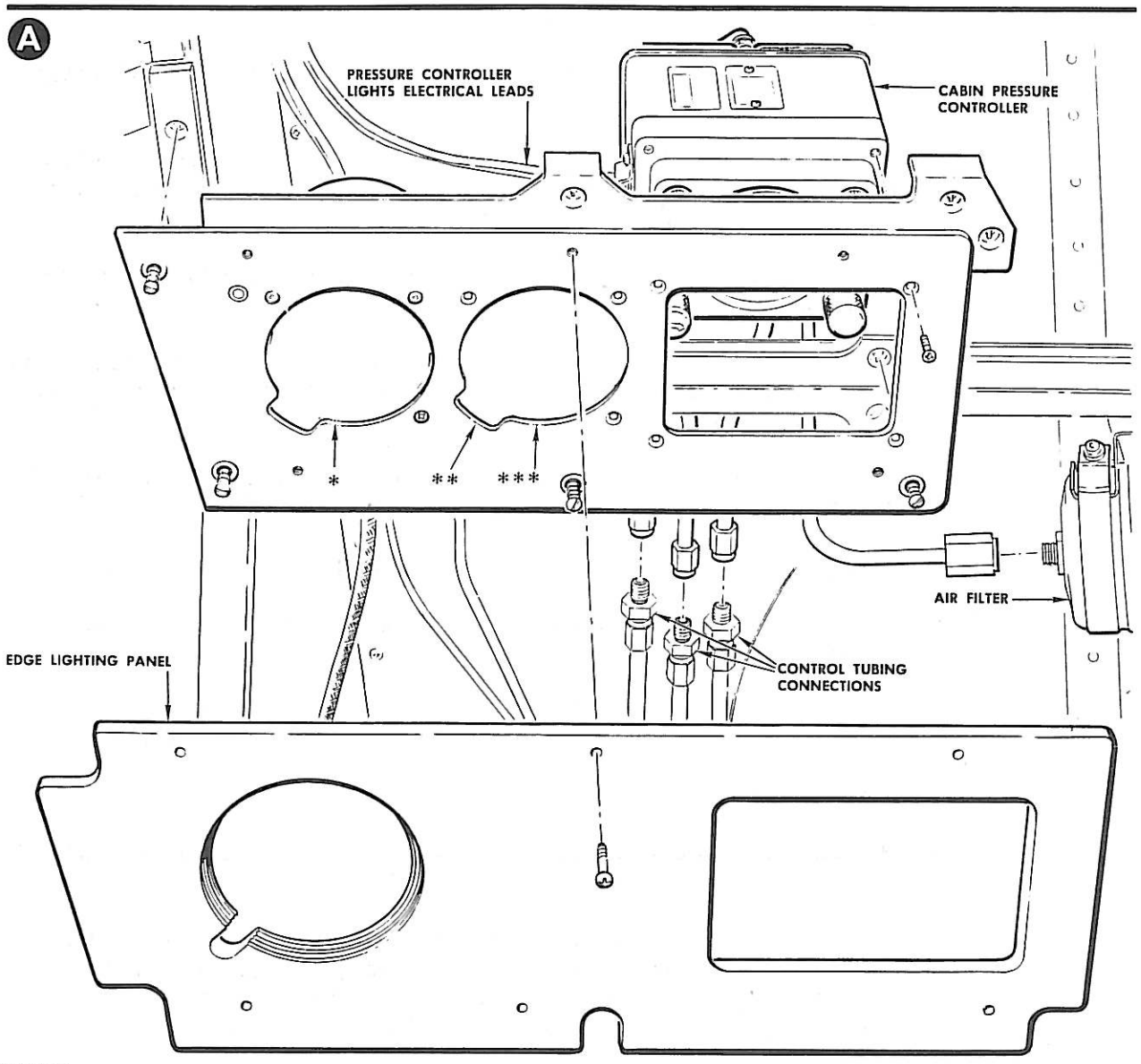
B. Install Cabin Pressure Controller.

(1) Install fittings and four short pieces of flexible hose on back side of replacement controller; tighten fittings.

(2) Position cabin pressure controller over three tubing connections behind instrument panel; connect and secure flexible hoses from controller to airplane tubing while supporting weight of controller. (Avoid twisting or bending tubing or flexible hoses.)



EFFECTIVITY	
APPLICABLE TO AIRPLANES	
*	RATE-OF-CLIMB INDICATOR (CV-1 THROUGH CV-34)
**	CABIN ALTIMETER (CV-1 THROUGH CV-25)
***	RATE-OF-CLIMB INDICATOR (CV-35 AND ON)



Cabin Pressure Controller Installation
Figure 201

CONVAIR MODEL 30

MAINTENANCE MANUAL

TEMPORARY REVISION NO. 21-21.

Insert facing 21-2-1, Page 203, dated Nov. 15/62 (or subsequent).

The information in this temporary revision is applicable to airplanes prior to incorporation of Convair COR 30-22019. For airplanes modified per COR 30-22019, use the information on Page 203.

Retain this temporary revision in your manual until applicable airplanes have been modified per noted COR.

Page 203, in steps 1.B.(3), 2.B.(3) and 2.C.(2) substitute the word "tubing" for "flexible hose."

(3) Connect and tighten flexible hose from controller to controller air filter.

(4) Position instrument panel in front of cabin pressure controller and secure panel to airplane structure with fasteners.

(5) Secure instrument panel to cabin pressure controller with four screws.

(6) Install plastic edge-lighting panel on face of instrument panel; secure plastic panel with six screws.

(7) Connect instrument light electrical leads to terminals on side of controller.

(8) Perform leak test of cabin pressure controller static sensing system (refer to 21-2-0, Adjustment/Test).

(9) Close flight engineer's forward and aft hinged control panels, and the engine fuel control panel (refer to Chapter 34, NAVIGATION).

(10) Close FLIGHT ENGINEER PANEL LTS circuit breaker.

(11) Perform Adjustment/Test in 21-2-0, PRESSURIZATION CONTROLS AND INDICATION.

2. Removal/Installation Cabin Pressure Controller Air Filter (see Figure 201)

A. Equipment Required - None.

B. Remove Cabin Pressure Controller Air Filter.

(1) Open FLIGHT ENGINEER PANEL LTS circuit breaker.

(2) Gain access to filter by opening flight engineer's engine fuel control panel (refer to Chapter 31, INSTRUMENTS).

(3) Disconnect flexible hose connection on back side of filter housing. (Cap open hose.)

(4) Loosen clamp securing filter housing to mounting bracket and remove filter housing.

(5) Replace filter element and clean filter housing and orifice (refer to Chapter 12, SERVICING).

C. Install Cabin Pressure Controller Air Filter.

(1) Place filter housing in mounting bracket and secure with clamp.

(2) Connect and tighten flexible hose connection to fitting on back side of filter housing.

(3) Close flight engineer's engine fuel control panel (refer to Chapter 31, INSTRUMENTS).

(4) Close FLIGHT ENGINEER PANEL LTS circuit breaker.